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ABSTRACT

This document contains the final performance report, evaluation, and curriculum from a program that provided basic literacy instruction for employees of Chahta Enterprises in Mississippi. The final report describes development of curriculum materials that matched the reading and math tasks of production and quality control jobs; reading and math classes that were prerequisites to the mandated Statistical Process Control (SPC) class; and classes in English as a Second Language. The external evaluation report notes these findings: a slow economy led to the training of fewer employees than proposed; more than 90 participants gained skills; the program was appropriately managed; and need for literacy instruction still existed, especially with the non-English speakers. The curriculum guide consists of 18 modules. The first page of each module is a cover sheet that lists the objectives and an outline of the content with approximate time limitations, a brief description of the method used, and materials. A teacher's guide suggests means of covering material in each session. Copies of all transparencies, handouts, and answer sheets are provided. Topics include the following: SPC terms, Chahta quality control, principles of SPC, metric system, decimal numbers, calculators, inspecting for SPC, problem solving for quality, and communicating for quality. A posttest is provided. (YLB)

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ED 360 550

WORKPLACE LITERACY PROGRAM
V198A10229

FINAL PERFORMANCE REPORT

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Choctaw Workplace Literacy Program

The Adult Education Department of the Mississippi Band of Choctaw Indians and Chahta Enterprise were working partners for basic literacy instruction through the National Workplace Literacy Project. The purpose of the program, which began in March 1991, was to provide the basic literacy instruction for certain employees of Chahta Enterprise. The program was a response to the defined need for the basic literacy instructional services among Chahta Employees who were required to complete the Ford-mandated Statistical Process Control class. The program provided the Chahta Employees with basic literacy needs, including reading, writing, listening, speaking, and math skills, all of which are job-specific.

The Workplace Literacy place project met the needs of these employees through achievement of the following goals:

(1) the development of curriculum materials which match the reading and math tasks of production and quality control jobs;

(2) the conduct of weekly, in-plant classes which follow the referenced materials to teach math and reading skills required of Chahta employees and which are the essential prerequisites to Statistical Process Control; and,

(3) the conduct of weekly, in-plant English as a second Language classes for employees whose limited English proficiency require this instruction as a prerequisite for other training.

1. Compare actual accomplishments to the objectives

(1) The program will use its first ninety days of operation to identify, screen, and assess 610 Chahta Enterprise employees for participation in the program. Each participant will be given the ABLE, ESL/Literacy scale, attitude scale and a task analysis to determine literacy strengths and needs. Ninety per cent of the applicants will be placed in appropriate instructional plan.

Due to the reduction in workforce due to the recession 250 to 300 employees were tested on the SelectABLE the placement test for the ABLE (Adult Basic Learning Examination).

Approximately, 100 employees were selected by the CEO and other management personnel to receive the first phrase of Workplace literacy instruction. Test times were arranged for all of these 100 employees to take the ABLE. The ESL/Literacy scale was

initially administered but was found not to be an appropriate testing instrument for participants who were limited English proficient. The ESL specialist administered an informal ESL test to these particular group.

Class group assignments were determined by, a combination of testing, job performance requirements and employer assessments.

One-hundred Chanta employees, with the greatest need to be served, entered training in a 22 weeks program in the fall, 1991. 20 were placed in English as a Second Language classes. A new group of 100 were enrolled in training in the spring 1992 and additional 14 ESL students were placed with the first ESL group. Chanta employees who enrolled in the program attended in-plant classes for one hour per week.

In the first phase of the program, 52 employees successfully completed the program. In the 2nd phase 56 employees successfully completed the program.

(2) The program will develop basic literacy skills and coordination of occupation-focused instructional services to address specific needs of Chanta Enterprise employees.

Two types of curriculum materials were developed. Dr. Walter Howell the State Project Coordinator for the Mississippi Skills Enhancement Training Program assisted project staff members with a task analysis of different jobs to determine job-specific curriculum content. The task analysis strategies included: 1) determining those basic skills required of employees for effective job performance at Chanta; 2) conduct of a one-day observation of employees, determining requirements for reading, writing, math calculations, estimating, measuring, graphing; 3) noted the actual materials used by the employee to perform job tasks involving basic literacy skills; and 4) determined the specific purpose of job tasks, and noted whether tasks are performed individually or as a group.

The State Project Coordinator assisted with the development of materials to be used for the basic literacy classes. The program staff met with management to review the curriculum before it was implemented. These classes taught math and reading skills required as prerequisites for Statistical Process Control. This curriculum consisted of 20 lessons with pre-tests and post-tests to assess student progress.

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The English a Second Language Specialist for the project developed a curriculum to use with the ESL students in her classes. The curriculum included three strands of Workplace/Chahta Enterprise, Choctaw Culture, Family/Home, informal evaluations measures, and lessons which were developed for each student, according to his/her individual needs.

The participants have progressed, but needed much more intensive instruction.

(3) The program will result in demonstrated improvements of workplace skills required for the efficient and productive performance of jobs at Chahta Enterprise, to include job skills transfer, as measured by the number of employees who successfully transfer from one position to another, and increased workplace literacy in the use of written and spoken language, math, and thinking skills as measured by the ABLE, and other assessments.

Twenty of the employees (who participated in the program) moved to another position according to the personnel manager.

62% of the workplace participants increased in the area of basic skills as measured by ABLE and other assessments.

With the ESL participants, their supervisors noted increase workplace literacy especially in the area of verbal and written English.

II. Refer to the schedule of accomplishments and their target dates contained in the approved application and give reasons for slippage in those cases where established objectives were not met. Include any corrective measures taken to correct slippage.

A no-cost extension to September 1992 was requested and approved to complete necessary class sessions and post-testing with those program participants who were willing to continue. Some of these participants were behind in completing class sessions due to medical leave and pressing job duties.

III. Identify the number and characteristics of project participants who completed planned project activities and of those who did not, and the outcomes achieved by participants who completed project activities.

Direct services

1. Mean Age Participants: 35

2. Sex: No. Males 59 No. Females 89

3. Race/Ethnicity: No. Who are:
   White 18
   Black 11
   Am. Indian 119

4. No. Single Head of Household: 45

5. No. Limited English Proficient: 40

6. Outcomes

	No. Participants
a. Tested higher on basic skills	50
b. Improved communication skills	75
c. Increased productivity	25
d. Improved attendance at work	N/A
e. Increased self-esteem	108

7. Years with the company

	No. Participants
Unemployed	
0-5	65
6-10	39
11-15	4
16-over	

IV. Report any Dissemination activities.

On March 3-6, Susan Franks, ESL Specialist present a paper on ESL at the Eastern Education Research Association Conference.

On-Site Visits

In October, Mrs. Julie Mabus, Mississippi's First Lady, visited the plant to view the program and talk about our accomplishments.

On April 14, met with White Mountain Apache Delegation to give overview of the Workplace Literacy program and the group toured Chahta Enterprise.

V. Report on any evaluation activities.

The report of the external evaluator is attached.

Choctaw Workplace Literacy Program
Project Number V198A10229
Final Report
Jim C. Fortune
November 27, 1992

At the time of the development of the proposal and the award of the Choctaw Workplace Literacy Program Chahta a company consisting of two wire-harness and electronic components factories located in the industrial park on the reservation, employed more than 700 tribal members. These factories had received a Q-1 rating from one of their primary customers, the Ford Motor Company. In order to keep this rating Statistical Process Controls (SPC) had to be learned by the workers. The Choctaw Workplace Literacy Program sought to assist Chahta through the accomplishment of four major objectives: (1) to test between 200 and 300 workers at Chahta on the TABE; (2) to identify those workers with basic literacy needs; (3) to develop a 44 week program program to teach basic reading and mathematics so as to assist the workers in passing the SPC examinations; and (4) to implement this program to train approximately 580 Choctaw workers one hour weekly.

A task analysis showed that the proposal anticipated a longer instructional program than was required by the SPC work activities. An expert in SPC requirements was employed to build the curriculum and his efforts based on a task analysis resulted in a 22 week curriculum that could be implemented in one hour per week classes.

The beginning testing using the TABE ran into trouble immediately. The factory workers were less able to handle the English language and testing was more difficult and took longer than was expected during the development of the proposal. The ABLE examination was selected by the staff instead of the TABE, because the ABLE measures lower achievers more precisely than does the TABE. Approximately 200 workers were tested on the ABLE and the results were used for proposed diagnostics to identify 100 project participants. Approximately 40 to 60 workers were found to speak too little English to benefit from the planned curriculum in the SPC, so a special English as a Second Language (ESL) class was created.

The number of participants was limited to 100 workers due to economic problems encountered by Chahta. The fall and winter economic repression had an adverse effect on the automobile industry. The Chahta plant during the fall and winter suffered lay-offs and work force reduction to a point that the President of the Corporation simply would not release but 100 of the work force for training at the beginning of the contract. The work force at the time of this decision had been reduced to less than the 500 workers. The performance report of January, 1992 noted the changes in project design that was required by the economy and reported the implementation and training accomplishments that were made during the first half of the program.

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Performance over the first half of the project included a revision of the proposed test battery to accommodate worker difficulty with English, the testing of 200 Chahta workers on the TABE, the development and implementation of a 22 week training program with a 100 Chahta workers, and the development of a specially designed program for non-English speakers.

In Table 1 are shown the t-tests comparing the results of the attitude scale administration on the three subtests and the total scores on the attitude scales and the t-test on the pretest and posttest SPC tests for the first half of the project year. The t-tests used were tests for independent means due to the number of dropouts from the pretest, 59 to 41. A dependent t-test was made on the 41 tests which could be used. Only one subscale and the total attitude score showed change. Improvement was shown for social subscale and for total score on the attitude scale and a large improvement for the SPC examination. Thirty nine of the forty-one passed the company SPC examination.

Table 1: Change on Attitude Scales and Statistical Process Control Tests

Subscore	Pretest Statistics Num.	Mean	St. Dev.	Posttest Statistics Num.	Mean	St. Dev.	t	p
Attitudes								
Work-Related	59	6.54	8.47	41	5.29	6.88	0.77	ns.
	37	5.08	7.63	37	5.68	6.87	0.78	ns.
Consumer	59	9.88	8.12	41	8.20	7.70	1.03	ns.
	37	8.08	7.68	37	8.29	7.97	1.07	ns.
Social-Related	59	10.00	7.60	41	7.12	7.32	1.87	0.05
	37	10.24	7.93	37	7.32	7.45	1.88	0.05
Total	59	26.42	20.23	41	20.61	18.63	1.44	0.10
	37	23.39	18.65	37	21.29	19.06	1.29	ns.
Statistical Process Control Test								
SPC	59	44.54	13.95	37	84.54	15.81	12.85	0.01

In Table 2 are shown the responses to the exit interview of 48 of the trainees. The median responses were extremely positive. Confirmatory interviews with 17 of the trainees suggest that they found the mathematics (or arithmetic) most helpful and most appreciated and they enjoyed renewing their reading skills. Only a very few actually can read. Most of those interviewed expressed interest in additional tutoring and entry into adult basic education. The secondary benefit of understanding their children's school work served as a secondary reinforcer.

The President of Chahta attributed the first half year of the project with the successful completion of the SPC

requirements by more than 40 workers. Given this success at mid-year another group of 100 workers were identified for a second wave of the training project.

Table 2: Median Responses on Exit Interview

Item	Median Response	Number in Agreement
Program useful	yes	48 of 48
Help know about job	yes	46 of 48
Able to use off work	yes	28 0f 48
What you expected	yes	24 of 48
Material too difficult	no	27 of 48
Instructor prepared	yes	45 of 48
Material presented well	yes	41 if 48
Length of program session	just right	28 of 48
Length of program (in weeks)	just right	25 of 48
Like to participate again in similar	yes	36 of 48

The non-English speakers appear to be a special case. Their program was not complete at the end of the mid-year and twelve agreed to continue to study for the second half of the project year. Those continued from the first half along with a second group of twenty non-English speakers made up the ESL component of the project. The twenty new students were also started at a beginning level in the second half of the program.

The start of the second half of the project year brought about the regrouping of staff and and a second diagnostic testing to identify second half participants. Again, testing did not run smoothly due to lack of stability of work schedules in the factories. At this stage of the year, the automobile industry enjoyed a mild upward surge and some of the laid off workers were returned to work. This change in work force resulted in variations in composition of assembly lines and caused some potential participation problems.

In Table 3 are shown the results of the second half instructional program. Again, 100 participants including the 32 non-English speakers started this phase of the program. Changing line assignments and reassignments resulted in more than half of the participants having to miss several classes. The second half program had results very similar to those found in the first half

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program. No significant changes were observed for attitudes toward work related learning, but positive changes in attitudes were found for social and consumer related learning. Second half trainees averaged 72% attendance to classes whereas first half participants averaged 86% class attendance.

Table 3: Comparisons of Attitude Measures: Sample Sizes, Means, Standard Deviations, and t-test Coefficients

Subscale	Data Point	Sample Size	Mean	Standard Deviation	t	Sign
Work-Related	Pretest	68	15.88	7.92		
	Posttest	41	17.39	8.08	0.95	ns
Consumer-Related	Pretest	68	13.43	6.70		
	Posttest	41	15.90	7.02	1.82	0.05
Social-Related	Pretest	68	8.06	5.80		
	Posttest	41	11.44	5.01	3.07	0.01
Total	Pretest	68	45.09	18.94		
	Posttest	41	50.90	21.55	1.46	ns

In Table 4 are reported means and standard deviations of second half participants on the SPC test and on the ABLE. Please note that the second half participants appear to have equaled or out-performed the first half participants on the SPC posttest. This should assure the reader that the instruction was effective and nearly equivalent. The ABLE was administered to a sample of the participants to estimate the equivalent difficulty of the material to the standard adult education curriculum. One may note that average performances on all subtests except those for language arts exceed the 50 NCE level, equivalent to the adult education expected performances. The below par performance on

Table 4: Levels of Test Performance: Second Half of Program

Test	Sample Size	Mean	Stan. Dev.
SPC	41	85.610	10.217
ABLE (in NCE's)			
Vocabulary	25	51.960	14.520
Reading Comprehension	25	51.480	27.994
Spelling	25	65.320	19.768
Language	25	36.640	11.637
Total Language	25	46.200	10.673
Number Operations	25	50.720	25.612
Problem Solving	25	53.680	13.667
Total Mathematics	25	51.080	18.665

the language subtests perhaps is reflected of the ESL characteristics of the participants. Overall, the academic performance of the participants for the year is very satisfactory.

The evaluator interviewed a sample of a seventeen participants and the instructional staff for the first half of the program and sixteen participants and the instructional staff for the second half of the program. The students were very positive about the program, had little educational attainment, and were eager to learn, but had few study skills. The project staff were very concerned over the students and were very proud of the students' progress.

In Table 5 are reported the results of the exit interviews of the forty-one participants completing the regular instruction the second half of the project year. The median responses were again very positive. Eighty three percent found the program useful. Over 70% found that the project helped them on their job and that they were able to use the project off the job. The project was not what most expected and more than half found it too difficult. The participants found the instructors prepared and the materials appropriately presented, but the number and duration of instruction were felt to be too short. Most reported that they would participate again. Bilingualism and lack of prior success with academics appeared to be factors in the rating of the program by the participants.

Table 5: Median Responses on Second Half Exit Interview

Item	Median Response	Number in Agreement
Program useful	yes	34 of 41
Help know about job	yes	32 of 41
Able to use off work	yes	30 0f 41
What you expected	yes	14 of 41
Material too difficult	no	25 of 41
Instructor prepared	yes	40 of 41
Material presented well	yes	41 if 41
Length of program session	too short	30 of 41
Length of program (in weeks)	too short	28 of 41
Like to participate again in similar	yes	28 of 48

Table 6: Pretest and Posttest Means and Standard Deviations on Work Place Literacy Attitude Scale (n=89)

Item	Pretest		Posttest	
	mean	stan/dev	mean	stan/dev
Helps money handling	1.932	0.509	1.902	0.297
Helps learn about far away	1.721	0.538	1.659	0.609
Directions makes work easy	1.721	0.802	1.902	0.297
Fail to get promotion	0.426	1.478	0.268	1.397
Feel better about coworkers	1.294	2.870	1.415	0.826
Learn job opportunities	1.676	0.865	1.659	0.719
TV is more fun	0.971	1.414	1.098	1.246
Figure salary for weeks, month	1.456	0.977	1.634	0.982
Helps plan a budget	1.471	0.931	1.707	0.594
Helps see price of credit	1.191	1.179	1.610	0.728
Understand worker benefits	1.544	0.882	1.366	0.904
Talks to off reservation folks	1.118	1.301	1.488	0.991
Read conditions on contract	1.706	0.749	1.585	0.910
Helps learn world affairs	1.456	1.021	1.268	1.230
Co-workers are jealous	-0.779	1.570	-0.659	1.571
Help me to study on own time	1.485	1.064	1.537	0.990
Talk better on telephone	1.044	1.311	1.293	1.042
Helps compute lunch tab	0.529	1.519	1.146	1.260
Helps read work schedules	1.500	0.883	1.512	0.830
Feel I can advance in company	1.221	1.069	1.317	0.895
I can write business letters	1.382	0.924	1.220	1.220
Helps to write good reports	1.662	0.759	1.439	0.912
Get books at library	1.618	0.875	1.817	1.652
Helps me meet new friends	1.029	1.306	1.585	0.910
Not needed to make change	-0.338	1.559	-0.780	1.440
Do not need to read	-1.279	1.235	-1.049	1.287
Not needed to shop	-1.412	1.179	-1.220	1.220
Never have to read directions	-1.191	1.353	-1.195	1.273
Not useful in grocery shopping	-1.294	1.273	-1.463	1.191
Able understand production data	0.176	1.514	0.683	1.439
Others will read graphs for me	-0.926	1.332	-1.366	0.982
Not help to use want adds	-0.897	1.446	-0.854	1.424
TV fun with out English	-0.279	1.652	-0.415	1.608
Only know what I get on payday	-0.279	2.129	-0.439	1.668
Budget planning requireas more	0.000	1.553	-0.463	1.345
I am told my monthly notes	-0.279	1.570	-0.707	1.452
Not understand work benefits	-1.382	1.176	-1.268	1.169
Seldom need English off reserv.	-0.618	1.600	-0.780	1.490
Confusing to go to library	-1.191	1.320	-1.390	1.056
Supervisors need prod. data	-0.559	1.621	-0.902	1.445
Important to read graphs	1.368	1.175	1.171	1.208
Not help to talk on telephone	0.956	1.992	-0.488	1.610
Math is a waste of time	-1.529	1.104	-1.585	0.987
Work schedules hard to read	0.706	1.505	-1.024	1.334
Helps to compare packages	0.426	1.537	0.756	1.478
Not to write business letters	-0.412	1.466	-0.415	1.414
Shopping made easy	1.029	1.372	1.220	1.335
Not help to communicate	-1.279	1.270	-1.366	1.121

In Table 6 are shown combined first and second half means and standard deviations for participants on the attitude scale. The scales were scored with a +2 to an agree on a positive item, a +1 to a tend to agree on a positive item, a -1 to a tend to disagree on a positive item, and a -2 to a disagree to a positive item. Scores were reversed for negative items. Fourteen items appeared to shift considerably from pretest to posttest. After the twenty-two week program the participants tended to agree more with statements suggesting that: reading directions help make the job easier; the project helps them to handle money better; the project helps them to figure their salary for days, weeks and months; the project helps them to plan a budget; the project helps them to learn about world affairs; the project helps them to talk better on the telephone; the project helps them to meet new friends; and it is confusing to go to the library. They tended to disagree more with statements suggesting that: they may fail to get a promotion; they can write better business letters; they can write good reports; the project failed to help them handle money; reading was not needed by them; and reading and mathematics were not needed for shopping.

The ESL class for the most part did not achieve beyond the floor of the ABLE. Ten of the twelve year long participants and fourteen of the twenty last half year participants completed the the ESL part of the program. All students that completed the ESL instruction learned to recognize environmental signs such as danger, step down, wear hard hat, etc. The students who attended both halves learned to read and complete workplace forms, such as down time reports, labor reports, food service forms, application forms, and materials waste forms. All of these students learned to use factory related visual aids and instructional diagrams. All of these workers gained competence in conversational English and basic simple addition and subtraction facts. The second ESL participants learned to recognize environmental signs, to read tables, charts and graphs (work related) and to do basic addition and subtraction. One half of this group learned multiplication tables and half of this group learned simple fractions. Four only learned to write their names and the simple recognition tasks. In fact fourteen of the participants in the ESL program received commendation from their supervisors.

IN SUMMARY

The program was operated in the spirit of the Workplace Literacy Program. A slow economy and need to cut the work force lead to the training of less than was proposed, but for those trained the program was effective and the instruction did help Chahta keep the Q-1 rating. More than 90 individuals gained skills that will be permanent contributors to their work potential. A quality curriculum was developed, a quality staff was assembled, the program was appropriately managed, but the logistics and economy robbed the program of some potental. Need still exists, especially with the non-English speakers.

BASIC SKILLS

FOR

STATISTICAL PROCESS CONTROL
(SPC)

Philadelphia, Mississippi

Chahta Enterprise

Mississippi Band of
Choctaw Indians

Mississippi State
Department of
Education

Governor's Office
for Literacy

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ORGANIZATION AND CONTENT

Materials for this program have been divided into modules. Each of these 20 modules has a set of objectives which should develop knowledge and skills the participants will need in order to accomplish the course objectives. The first page(s) of the modules or sessions is a cover sheet which lists the objectives for that session and an outline of the content. The outline has approximate time limitations, a brief description of the method used to teach that portion of the class and materials listed which will be needed.

Each session calls for a brief overview of the previous session at the beginning. There is time allotted at the end of each session for participants to go back over the objectives of that lesson. The purpose of this is to help keep the class focused on what has been taught, provide a check to be sure all objectives have been covered, and allow for questions and answers about anything which might have been unclear.

A teacher's guide is provided which is a suggested means of covering material for each session. It is just as it is called - a guide. An instructor should not feel as if he/she has to use the guide exactly as written. The purpose is to give suggestions for questions, activities, etc. The important role of the instructor is to guide participants into learning what they need to know, and help them to understand how and why things are done as they are. As long as an instructor facilitates that learning - how is unimportant, and will vary with the learning and teaching styles of individuals teachers and the students they have.

In the first couple of sessions, there are anticipated questions and answers. These are only in the first few sessions, because for most participants the goals of the program will not be completely clear. If in the first sessions, the instructor can provide as many answers as possible and present them in an honest, helpful, and positive manner, the anxiety of learners should be reduced. This will help to create an environment more conducive to learning. These questions and answers are also a means of being able to provide you, the instructor, with information you might find helpful in teaching the course.

Copies of all transparencies, handouts, and answer sheets are provided for the instructor. Handouts are marked with an "H" at the top of the page; "A: for answer sheets, and "T" for transparencies. Many transparencies are also given as handouts.

RECORD KEEPING

Record keeping is an important part of the regular classroom process. Chahta Enterprise is interested in having employees attend class as regularly as possible. They may request attendance information during or at the conclusion of the program. A roll will be provided. You will need to document who is present and who is absent. It a participant is late or leaves early, the time they arrived or the time they departed should be documented. This information will be needed to determine who will be eligible to receive certificates at the conclusion of the program.

Breaks have not been scheduled in the time-lines. It will be up to you to determine if a break is warranted. Remind the participants that if they are on time and are focused on the training, it will be easier to schedule a break.

It might be wise to make a statement about "being on time" at the end of each session, if tardiness becomes a problem.

Again, congratulations on being selected to serve as the trainer for this program. It will be a rewarding experience for you. Good luck!!!

INSTRUCTOR'S GUIDE

You have been selected to participate in an exiting opportunity. You will have the privilege of proveding instruction to a group of knowledgeable and experienced employees of Chahta Enterprise. Although the goal of this program is to enhance their knowledge and skills, you too will learn from your association with them.

Adult Learning Principles

Adults, as students, come to any new learning event with a reservoir of experiences and knowledge which can be used to build upon to teach them the new information they need to learn. How-ever, adults also come into a classroom with pre-conceived ideas and perhaps even a great deal of apprehension. One of your greatest challenges, as an instructor, will be to turn that anxiety into a trusting and cooperative feeling, so that constructive learning environment can be created.

Some helpful ideas to remember are:

* Adults need to know why they should learn something. They learn best when they understand how the new knowledge will be immediately useful in their work or personal lives.

* Adults need to be self-directed in their learning. They want to be in charge of their lives and responsible for the decisions they make. They need to be quickly shown that "learner" and "dependent" are not synonymous. They need to participate in choosing and planning their own learning activities.

* Adults need to have their experiences respected and considered a resource for the learning process. There should be emphasis on hands-on techniques that draw on the learner's accumulated skills and knowledge (such as problem solving, case studies, or discussion) or techniques that provide learners with experiences from which they can learn (such as a simulation).

* Adults make a voluntary commitment to learn when they experience a real need to know or to be able to do something. They do not respond to an authority figure saying it will be good for them.

* Adults have a task-centered or problem-centered approach to learning. For children, learning is organized around subject matter. For adults, learning should be organized around real tasks. "Composition" becomes "How to Write Effective Business Letters."

* Adults are motivated to learn. They respond to extrinsic motivators like higher wages and promotional possibilities, but even more to intrinsic motivation like the need for self-esteem, recognition, broader responsibilities and achievement.

* Adults need to have the process of learning considered carefully. The focus is not on the instructor transmitting the content but on the learner acquiring it.

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Adults need to have feedback regarding their learning. They want clear learning objectives, and they want to know regularly the extent to which their objectives have been achieved.

Remember

People generally recall:

- 10 percent of what they read,
- 20 percent of what they hear,
- 30 percent of what they see,
- 60 percent of what they hear and see.
- 70 percent of what they say or write, and
- 90 percent of what they say as they do it.

By allowing participants to feel free to share their experiences and knowledge, they will become more involved in the training process. This will also prevent the program from becoming teacher oriented. Less than 50% of any class should be dominated by the teacher. The bulk of each session should evolve around student participation in various types of activities.

Skills Enhancement Program

One of the major factors which make the Skills Enhancement Program different from other on the job training is that concepts are taught. It is important for the learner to understand the how's and why's of what is being done. This is frequently accomplished by ask participants to explain how they do things so they express the mental processes behind their actions. It is believed that this will lead to the students being able to transfer what they learn into real life situations and on the job.

CHAHTA ENTERPRISE
Basic Skills for SPC

Course Outline

Session I - Introduction/Overview
Course Overview
Demographic Data

Session II - Introduction to SPC
Define Quality
Quality in Relation to Job
Pre-Test

Session III - SPC Terms
SPC Terms

Session IV - Chahta Quality Control
Importance of Quality Control to Chahta Enterprise

Session V - SPC, Chahta, and Me
Role of Employees in Quality Process
Importance of Documentation for Quality Control

Session VI - Principles of SPC
Variation, A Natural Part of Manufacturing Process
Use of Inspection to Control Variation

Session VII - Principles of SPC II
Documentation of Inspections of Process "In Control"
Documentation of Multiple Inspection

Session VIII - Principles of SPC III
Assignable and Common Causes of Variation
SPC Charts Currently Used at Chahta

Session IX - Control Charts & Metric System
Review and Overview

Session X - Decimal Numbers
Adding and Subtracting Decimal Numbers

Session XI - Decimal Numbers
Multiply and Divide Decimal Numbers

Session XII - Mathematics for SPC
Adding and Subtraction of Fractions

Session XIII - Mathematics for SPC II
Multiplying and Division of Fractions
Converting Fractions to Decimals

Session XIV - Inspections for SPC
Random Sampling/Visual Inspections

Session XV - Problem Solving for Quality
Major Steps of the Problem Solving Process
Cause and Effect Relationships

Session XVI - Problem Solving for Quality II
Planning for Improvements

Session XVII - Communicating for Quality
Importance of Positive Communication
Listening Skills

Session XVIII - Communicating for Quality II
Giving and Getting Feedback in Relation
to Effective Problem Solving for Quality

COURSE OBJECTIVE

Upon completion of this course, participants will be knowledgeable of the practices of Statistical Process Control (SPC); the participants will be able to document inspection data on control charts and take appropriate actions based on documentation findings and criteria established by quality assurance.

SESSION I **INTRODUCTION/OVERVIEW**

COURSE OBJECTIVES:

Upon completion of this course, participants will be knowledgeable of the practices of Standardized Process Control; participants will be able to document inspection data and take appropriate actions based on documentation findings and criteria established by quality assurance.

SESSION OBJECTIVES:

At the conclusion of this session, participants will:

recognize the basic requirements and expectations of the training program.

identify themselves, their jobs, and learning objectives for this program.

recognize general program content and expectations.

provide the Mississippi State Department of Education with data needed for State requirements.

TIME	CONTENT	PROCESS/ ACTIVITY	MATERIALS
5 Min.	Welcome & Session Overview	Lecture Objectives	Session
15 Min.	Introductions	Icebreaker	Flip-chart
10 Min.	Program Overview	Lecture	Course Outline
10 Min.	Demographic Data	Entry Data	Entry Form
15 Min.	CLOZE Procedure	Individual Written Activity	CLOZE Form

BASIC SKILLS FOR SPC

SESSION I — INTRODUCTION/OVERVIEW

INTRODUCTION TO THE PROGRAM

Welcome participants to the training program. Explain that this is a program being offered to them on company time by Chahta Enterprise, the Choctaw Workplace Literacy Program, the State Department of Education, and the Governor's Office for Literacy, and is designed to provide them with skills they will be using in their jobs. The goal of Chahta Enterprise is to provide them with a program which will help them as Statistical Process Control (SPC) is being incorporated into their jobs.

Explain basic logistics of the training program:

Program is designed for classes to meet once a week.

There are a total of twenty class meetings.

Briefly discuss the agenda for this session. Objectives are for the participants to:

recognize the basic requirements and expectations of the training program.

identify themselves, their jobs, and learning objectives of this program.

recognize general program content and expectations.

provide the Mississippi Department of Education with data needed for State and Federal funding requirements.

INTRODUCTIONS:

Explain to participants that you want to learn about them as quickly as possible; and want them to feel comfortable enough in class to actively participate.

Ask each participant to tell:

* his/her name (the name they go by)
* job they generally perform
* identify one thing he/she would like to learn by having participated in this class

As participants list their objectives, write them on the flip chart (to be addressed after introductions have been completed); as the course objectives and agenda are discussed. Be sure to give participants some information about yourself (i.e., name, home town, etc.)

MISSISSIPPI SKILLS ENHANCEMENT PROGRAM

Company Name_____ **Community College District**_____

ENTRANCE FORM

Identification Number: _____

Name_____ Date _____

Social Security No._____ Date of Birth _____

Age_____ Race_____ Sex_____ Are you a veteran? yes_____ no_____

What is the highest grade you completed in school? _____

How long have you worked here? _____

Job title:_____

How long have you held this job?_____

What other jobs have you held here?_____

Have you participated in company-sponsored training programs before? yes _____ no _____

If so, what?_____

Have you held other jobs? yes _____ no _____ If so, what?_____

Have you participated in other job training? yes_____no_____ If so, what?_____

Check any printed materials that you use on your job:

_____ forms _____ notes _____ none of these
_____ manuals _____ other (specify:_____)

Check any writing you are required to do on your job:

_____ reports _____ forms _____ memos _____ none of these
_____ summaries _____ notes _____ other (specify:_____)

Check any calculations that you are required to do on your job:

_____ keeping up with time _____ reading charts _____ none of these
_____ figuring percentages _____ other (specify:_____)

Do you use special measuring tools or technical equipment on your job?

_____yes _____no If so, what kind?_____

Are there areas in which you would like to improve your academic skills?

_____yes _____ no If so, what areas?_____

What do you hope to achieve as a result of participating in this program?

_____

_____

SESSION I

Directions: In the paragraphs below, there are blank spaces where certain words should appear. Fill in the blank spaces with the words you think should be there.

OPEN DOOR POLICY

Many problems that arise in industry today are a _____ result of poor communications. _____ believe good relations among _____ depend on good communication _____ full understanding among all _____ the company. We encourage _____ expression and we want _____ employee to feel free _____ talk to any member _____ management.

In keeping with _____ open door policy and _____ fairness and respect to _____ concerned, we suggest that _____ employee pursue the following _____ in solving a problem. _____, discuss the problem with _____ supervisor and give him/her _____ reasonable amount of time _____ help solve the problem. _____ the problem is not _____ and you feel that _____ discussion is necessary, then _____ should discuss the matter _____ your General Supervisor. If _____ wish to pursue the _____ beyond the General Supervisor, you should discuss the matter with your Personnel Supervisor.

PROGRAM OVERVIEW

Distribute copies of the Course Outline. Discuss briefly. Review the different sub-topics and let them know what will be addressed in the course.

DEMOGRAPHIC DATA

Distribute the "Entrance Form" to each participant. Explain that because of the federal and state funding involved in the project, that type of information is needed. Answer any questions the participants may have about the Entrance Form.

CLOZE PROCEDURE

Distribute the CLOZE Procedure sheet. Explain to them that this is a necessary procedure to identify certain reading skills. Point out that there is no place on the form for a name. That information is not wanted. The information from this procedure will be used only in a collective way. There are not individual scores.

SESSION CLOSURE

After participants have completed the CLOZE Procedure, take the sheets up. Ask the participants if they have any questions about what was covered at this session.

Brief the participants on the next session. At that time, they will take a Pre-Test. Emphasize that the Pre-Test is designed to test their present knowledge of Standardized Process Control (SPC). No participant is expected to do well on it. The reason the test is given is to establish a base-line of knowledge from which to measure how much they have learned by the end of the course.

SESSION II **QUALITY/PRE-TEST**

SESSION OBJECTIVES:

At the conclusion of this session participants will:

identify reasons for the importance of quality in today's market place, and why they should incorporate quality into each piece they produce.

relate that SPC requires the cooperation of each employee at Chahta Enterprise.

demonstrate areas of strengths and weaknesses of knowledge and skills required to document for SPC.

TIME	CONTENT	PROCESS/ ACTIVITY	MATERIALS
5 Min.	Session Overview	Lecture	Objectives
15 Min.	Define Quality	Brainstorm	"Quality Is..."
10 Min.	Quality in Relation to Job	Guided Discussion	
35 Min.	Pre-Test	Individual Written Evaluation	Pre-Test

SESSION II **QUALITY/PRE-TEST**

SESSION OVERVIEW:

Briefly review the objectives for this session. They are:

To recognize the importance of quality in today's market place.

To understand why quality should be incorporated into each piece produced at Chahta.

To understand that SPC requires the cooperation of each employee at Chahta Enterprise.

To demonstrate the areas of strengths and weaknesses of knowledge and skills required to document for SPC (the Pre-Test).

DEFINE QUALITY

Distribute the handout entitled "Quality". Ask participants to think about something they have bought that they were very pleased with. Have them tell you why they considered that product good. Ask them if they would consider that product a quality product.

Now ask them to define quality on their handout. Allow them a few minutes to do this. Then ask them to share their definitions with the rest of the group. Write their definitions down on the board and encourage them to write in definitions on their handout.

Possible definitions should include:

* a product or service that meets the customers's needs (it does what he/she thinks it should do).

* is made or performed (service) well - which may include:

  it doesn't fall apart
  looks good
  doesn't require constant maintenance
  user friendly

Then ask the group who determines quality. If they have difficulty answering that, ask them to reconsider the purchase they thought about earlier, and think about who in that case made the determination. Use their responses to help them to identify that it is the customer who defines quality.

QUALITY IS...

*

*

*

*

*

*

*

QUALITY IS DETERMINED BY THE CUSTOMER.

IMPORTANCE OF QUALITY TO INDUSTRIES

GLOBAL COMPETITION

CUSTOMER SATISFACTION

RISING CUSTOMER EXPECTATION

INCREASE PRODUCTIVITY

EMPLOYEE INVOLVEMENT

Anticipated Questions:

Why do I need to know what quality is?

Explain that this should be covered in a few minutes. If he is not satisfied with what he learns in the next part of the lesson, tell him to ask that question again.

What is quality?

Just as we determined - quality is defined by the customer. The product or service must meet the customer's needs. Industries have to constantly maintain customer contact to anticipate customer wants and needs; and then strive to meet those demands.

How do I impact on quality for Chahta? I only make one small part?

Every part impacts on the product; much the same as over or under seasoning your food affects its taste.

QUALITY IN RELATION TO JOB

Discuss the importance of quality. Below are some facts to include in this section.

global competition - Chahta has to compete with plants throughout the United States and even other countries for its customers. Because of this global competition, new technology is being introduced in plants like yours. Your old job skills are being obsolete and the new skills require more thinking and problems solving functions along with techniques for operating the equipment and understanding the overall job. Cross-training for all jobs is becoming very important.

importance of customers - without customers why would Chahta need to produce wire harnesses? And, without the need to produce, why would Chahta need employees?

rising customer expectations - customers today not only demand higher quality, but expect to pay less for it - isn't that the case with each of us?

quality production allows organizations to increase their productivity without increasing costs - in fact, cost is actually lowered. It is estimated that 1/4 of all work done in American industry is to re-work errors. This means that those industries could increase output by 25% without increasing costs. Quality production would also decrease waste, which would eliminate the cost of unusable parts.

successful quality improvement efforts involve all employees - the quality process breaks down it one employee is not producing a quality part. Each employee and each part is critical to the production and quality of the entire process.

Guided Discussion

Ask participants how all this relates to them in the performance of their jobs? If they have trouble getting started, ask them what part of the harnessing they produce or assemble; then ask if the harness would word without that part? Chances are, it will not.

The consensus of the discussion should be that if one employee is not doing his job well, the product will not be a quality product.

PRE-TEST

Distribute the "Pre-Test" to each participant. Provide them with the following instructions:

the results of this test will remain confidential

they will be allowed about 30 to 35 minutes to complete as much of the test as possible

they should answer the questions they can and then go back to the ones they were unsure of, if they wish and it time allows

They should do all the work on their own. The test is simply to determine areas in which they may need instruction

after they have completed the test they may leave

they should place their names on the test.

SESSION II

PRE-TEST

NAME: KEY

True or False - Place "+" in the blank in front of true statements and "0" in front of false statements.

\+ 1. SPC is a concept of "prevention" versus a concept of "detection".

0 2. Visual inspections are okay, but have no real role in quality control.

0 3. Because machines make parts, there is no difference between any two parts - they are all exactly alike.

\+ 4. Control charts can only measure characteristics which can be measured with precision instruments.

0 5. The probability theory says that we will never be able to tell what might happen next in a process.

\+ 6. Variations are caused by both common and assignable causes.

\+ 7. Improved quality will help to increase production and reduce costs of production.

\+ 8. SPC improves quality by allowing a worker to see what is happening and take quick action to prevent defects.

0 9. In order to find out what a printed sheet is about you would have to read the whole page.

0 10. Quality is the responsibility of Quality Control employees only.

\+ 11. A blueprint is to show the views and drawings of an object and how they fit together.

0 12. If we don't have hearing problems, we don't have any trouble listening to others.

\+ 13. We use our hands, arms, face, eyes, and other parts of our body to talk with more than we use our mouths.

0 14. There is no set way to problem solve, because a person's first response is always the best.

\+ 15. Decimals and fractions are just different ways of writing the same number.

T 16. The range on a control chart specifies how much discrepancy is allowed in the measurement of the part.

T 17. Most decisions are made or problems solved should be based on collected data.

T 18. Inaccurate data is worse than no data at all.

Multiple Choice - Write the letter of the best answer in the blank.

A 1. The three main purposes of collecting data are to:
   a. analyze, control, and inspect a product or process.
   b. locate, examine, and fire problem people.
   c. plot points, look at charts, and file away control charts.

C 2. Control Limit lines are:
   a. used to decide when to make adjustments to process or leave it alone.
   b. a statistical signal that something is abnormal and needs investigation.
   c. both of the above.
   d. none of the above.

D 3. The quality of a product is defined by
   a. the machine operator
   b. quality department
   c. supervisors
   d. customer

D 4. Quality is important to industry because of:
   a. customer satisfaction and expectations
   b. world wide competition
   c. will help increase productivity
   d. all of the above
   e. none of the above

B 5. 23" +/- 3/16" means that this wire can be cut in the range of
   a. 22 3/4" to 23 1/4"
   b. 22 13/16" to 23 3/16"
   c. No longer than 22 1/16"

B 6. SPC stands for
   a. Standard Production Capabilities
   b. Statistical Process Control
   c. Strategic Production Control

B 7. Sections of the blueprint which shows drawings and dimensions describing the parts of the assembly?
   a. bill of materials
   b. body
   c. title block

B 8. Most tools used in industries are based on the
a. Metric system
b. English system
c. American system
d. none of the above

B 9. One of the first leaders in quality control who has helped to develop many of its ideas and practices is:
a. George Bush
b. Edwards Deming
c. Lee Iacoca
d. Henry Ford

D 10. Random sampling is most desirable because it is:
a. cheaper
b. less time consuming
c. more accurate and less destructive
d. all of the above
e. none of the above

Add:

1. 1/4 + 8/16 = 12/16 = 3/4

2. 1 3/4 = 4/8
5/8 = 5/8
+ 1/2 = 4/8
1 = 15/8 = 2 7/8

3. .865 + .25 = 1.115

4. 25.16 + .005 = 25.165

Subtract:

1. 2 3/4 - 2/5 = 2 7/20

2. 3/4 - 3/8 = 3/8

3. 1.3745 - 1.3720 = .0025

Multiply:

1. 1 1/2 x 3/4 = 9/8 = 1 1/8

2. 21.3 x 1.2 = 25.56

3. 1.6 x 1.2 = 1.92

Divide:

1. 1/2 ÷ 1/4 = 1/2 x 4/1 = 2/1 = 2

2. 24.5 ÷ 1.4 = 17.5

3. 2.63 ÷ .8 = 3.2875

SESSION II

Using the chart below answer the following questions:

1. How far is it from New Orleans to New York?

1360

2. How far is it from Chicago to Los Angeles?

2115

AUTOMOBILE MILEAGE	Chicago, Ill.	Denver, Colo.	Houston, Tex.	Los Angeles, Calif.	Miami, Fla.	New York, N.Y.	San Francisco, Calif.
Atlanta, Ga.	671	1436	852	2245	663	868	2579
Boston, Mass.	992	2016	1865	3004	1615	220	3265
Chicago, Ill.	[illegible]	1062	1139	2115	1352	824	2240
Cleveland, Ohio	311	1393	1372	2393	1327	493	2571
Dallas, Tex.	923	820	241	1476	1367	1580	1790
Denver, Colo.	1062	[illegible]	1061	1148	2104	1794	1324
Detroit, Mich.	271	1333	1306	2415	1437	670	2511
Houston, Tex.	1139	1061	[illegible]	1585	1256	1714	1950
Las Vegas, Nev.	1905	843	1426	305	2572	2637	624
Los Angeles, Calif.	2115	1148	1585	[illegible]	2841	2784	411
Memphis, Tenn.	579	1054	560	1816	1050	1114	2214
Miami, Fla.	1352	2104	1256	2841	[illegible]	1395	3192
Montreal, Quebec	804	1866	1839	2948	1749	381	3044
New Orleans, La.	981	1326	360	1945	896	1360	2296
New York, N.Y.	824	1794	1714	2784	1395	[illegible]	3045
Philadelphia, Pa.	766	1770	1624	2726	1278	90	3021
Portland, Oreg.	2255	1329	2295	1098	3433	2992	687
St. Louis, Mo.	283	848	856	1832	1346	1057	2168
Seattle, Wash.	2076	1411	2377	1280	3421	2852	869
Toronto, Ontario	469	1531	1504	2613	1631	513	2709
Washington, D.C.	701	1696	1476	2690	1130	238	2968

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SESSION III **SPC TERMS**

COURSE OBJECTIVES:

Upon completion of this course, participants will be knowledgeable of the practices of Standardized Process Control; participants will be able to document inspection data and take appropriate actions based on documentation findings and criteria established by quality assurance.

SESSION OBJECTIVES:

At the conclusion of this session, participants will:

use basic skills in scanning, reading, and summarizing to learn about the relationship between quality and SPC.

TIME	CONTENT	PROCESS/ ACTIVITY	MATERIALS
15 Min.	Review	Lecture	Pre-test "Quality is . . . "
5 Min.	Overview	Lecture	Session Objectives
15 Min.	Introduction and History of SPC - Scanning	Guided Discussion	Quality & SPC
10 Min.	Practice Scanning	Q. & A.	Brief History of SPC
5 Min.	Reading for the Main	Guided Discussion	
10 Min.	Major Learning Points	Recap Major Objectives	

SESSION III INTRODUCTION TO SPC

REVIEW

Distribute the pre-test given at the last session. Allow the participants to look over their tests and answer any questions they have. Assure them that the test was intended to find out in what areas they needed instruction. Remind them that the test in no way will affect the outcome of their performance in this course; and that the State Department has secured the right to maintain the confidentiality of their class performance.

Explain that Chahta Enterprise's interest and the goal of this program is to improve their performance on the job.

Take-up the pre-test papers. Retain.

Review the class's definitions of quality discussed in the previous session. (If you have this on a Flip-chart, you may want to post it).

OVERVIEW

Using the blackboard or flip-chart, briefly discuss the objectives for this session, which are:

Using basic skills in scanning, reading, and summarizing to learn about the relationship between quality and SPC.

INTRODUCTION/HISTORY OF SPC

Distribute the handout entitled "Quality and SPC" and immediately ask:

What does the reading identify as the three major components of quality?

When someone answers the question correctly, ask him/her how they found the answer.

Guided Discussion:
Briefly discuss the value of scanning. Compare the similarity of scanning to something they are familiar with, such as being in a store and looking down a row of shelves to see if they can spot the particular item they're looking for -- you don't look at every can on the shelf.

Ask what they do look for. Answers might include: colors and pictures.

Inform participants that it is not always necessary to read every word on a page. Let them tell you why they scan the newspaper, a basketball or football roster, or a list of employee names. You should hear reasons which would include:

only interested in a particular product or person, etc.
don't have time to read the entire article
no real interest or value in everything else

Most reasons can be summarized by the fact that people scan when they are looking for specific information or answers; and the other information is of no value to them at that time.

Ask questions about scanning until you are able to establish the basic steps involved in scanning, which include:

1. mentally formulating a questions - usually done subconsciously
2. look for the words, letters, numbers, etc. that gave them the answer
3. not reading anything until they come to the part where they think they can find the answer

Ask when scanning is useful to them? Their answers should include such things as: looking up telephone numbers, reading newspaper ads, looking over lists to see if their name appears etc.

Practice:
Distribute the handout entitled "A Brief History of SPC."

Instruct participants to scan the SPC handout and answer the following questions. Ask each question and wait for a response (remember, this is a scanning practice).

What does SPC mean?
(Statistical Process Control)
What will SPC enable Chahta to do?
(meet quality standards of customers)
What is the goal of SPC
(produce things right the first time)
What will SPC measure?
(processes, not people)
What is the focus of all SPC programs?
(improving quality, preventing and eliminating errors).

As you go through the questions have them explain how and where they found the answers. Be sure they understand and can use scanning skills.

READING FOR MAIN IDEAS

Introduce reading for main ideas or skimming by telling participants that we often don't read printed information which might benefit us because it looks too long. By looking for main ideas, we can find the information we want or need without having to read every word or part of printed materials.

Guided Discussion:
Instruct participants on how to read for the main ideas. Begin by explaining that even though they have learned some information about SPC by scanning the handout, by looking for key words, numbers, etc. that would answer questions. There is a lot more they can get from the material by looking at the handout more carefully. Explain that a quick way to do this is for them to look for the main ideas.

Allow them the opportunity to describe how this can be done. You might suggest that they think about how they read the newspaper. Ask if they read every word of it; almost nobody does. Using the newspaper as an example, they should be able to describe at least parts of the procedure for reading for main ideas. Between what they tell you and what you fill in, the following major points should be covered:

1. look for key sentences -- often the topic sentence which is usually the first sentence of a paragraph, although it sometimes is the last sentence.

2. look for headings, subheadings, marginal notes, final summaries, italicized or bold print, and other ways of emphasizing what is considered to be important.

3. pay special attention to introductory and/or concluding paragraphs.

4. use the scanning technique of looking for key words, phrases, numbers, etc.

MAIN LEARNING POINTS

Close the lesson by telling participants that they will practice "reading for the main idea" at the beginning of the next session. Remind them to turn in their handouts for use at the next session.

Briefly recap the major learning points relating to scanning and reading for the main idea.

SESSION III (Handout)

QUALITY AND SPC

COMPONENTS OF QUALITY

A. **DESIGN**

Engineering is responsible for designing a good product and machine design. They must be sure that the specifications and models they provide reflect a quality product. In order to do this they need feedback from workers to locate possible improvements and processes that are difficult or won't work.

B. **WORKMANSHIP**

Employees are responsible for operating the machines and performing their jobs according to job requirements to the best of their ability. They are also responsible for reporting any problems that they have to their supervisor. If something is wrong, they need to let someone know about it. If they have an idea that may improve the product, they should tell someone.

C. **PROCESS CONTROL**

Quality control and employees monitor the parts of production. Their job is to insure that parts meet specifications.

When a product is designed for quality and employees use good **workmanship** and **process control** in performing their job, the result is a quality product.

SPC HELPS TO IMPROVE QUALITY BECAUSE IT:

A. Tells when things go wrong

B. Directs where and why design specifications are not being met

C. Allows the workers to:

1. Predict problems in the manufacturing process
2. Determine the effectiveness of process change
3. Prevent production of defective parts

D. Allows reductions in the costs of production because it helps determine if design specifications are being met. Failure to produce parts that meet design specifications means high cost and low productivity.

A BRIEF HISTORY OF SPC

During World War II, in spite of shortages of raw materials and a relatively small and inexperienced work-force, American industries enjoyed monumental successes in manufacturing. This was mainly due to a group of statisticians. These statisticians were responsible for successfully implementing control methods in American defense industries. These methods enabled a largely unskilled work force to produce large quantities of high-quality war materials. These efforts were pioneered in the 1930's by Dr. Walter Shewhart of Bell Laboratories.

At the end of World War II Japan lay in ashes. Its economy was in ruins and the island nation was poor in natural resources. In 1950 the Japanese Union of Scientists and Engineers invited Dr. Edwards Deming to Japan. The purpose of his visit was to explain quality control concepts to Japanese manufacturers.

The Japanese knew that in order to rebuild their economy and gain status as an industrial nation, they would have to change their manufacturing methods. The phrase "Made in Japan" had come to mean junk.

After learning about Japan's manufacturing methods, Dr. Deming called a meeting of forty-five of the leading Japanese industrialists. At this meeting, Deming told everyone that if Japan adopted his method of implementing statistical process control, they would capture the world market within five years and

take their place as a wealthy nation. It took longer than five years, but no one can deny that by the 1970's the way other countries felt about Japanese products had greatly improved. Today Japan is regarded as one of the world's greatest industrial powers.

It is interesting to note that while the Japanese were being introduced to the concepts of continuous improvement and statistical process control, American industries had begun to move away from them. American manufacturers may have felt that there was nothing to be gained by continuing to use proven methods which might slow down production.

American industries began to concentrate on quantities of produced items. The cost of lots of scrap and costly rework operations were addressed by American management by increasing the sale price of the product. These new practices not only caused higher prices, but they also resulted in defective products being sold to the consumer.

Improvements in Japanese products occurred because the new owners instructed the local workforce in the tools and techniques of statistical process control, continuous improvement, and the project team concept of problem solving.

As the United States enters the 1990's, the lawn mower industry, like many other American businesses, is feeling the effects of foreign competition. American industries must make statistical process control one part of an overall continuous improvement effort to be competitive in the world market.

SESSION III (3)

Low costs and quality products are what consumers want. Many consumers will buy foreign goods when the quality is as good or better, and especially when American made products cost more.

QUALITY GURUS

W. Edwards Deming

Introduced statistical methods to Japan after World War II.

He believes that quality products are achieved by defining and re-defining the customer's needs over and over again.

Joseph Juran

Defined quality as "fitness of use." Juran emphasizes the importance of the design as the beginning of the way to improve quality products.

Philip Crosby

Made the term "zero defects" popular as a goal for quality in industries.

Masaaki Imai

Author of Kaizen, believes in a philosophy of gradual, unending improvement. He feels that doing little things better is the key to improvements in quality and productivity.

STATISTICAL PROCESS CONTROL
Main Idea Activity

_____ 1. What SPC intended to measure

_____ 2. Country where industries used process control during World War II but stopped in the 1950's.

_____ 3. How American industries have made up for cost of remakes and scrap.

_____ 4. Defined quality as "fitness for use"

_____ 5. Philosophy of gradual and unending improvement

_____ 6. Country that began using SPC after World War II

_____ 7. Idea popularized by Philip Crosby

_____ 8. Believed that the customer defined quality

A. Edward Deming
B. Japan
C. Joseph Juran
D. Kaizen
E. process
F. United States
G. increasing cost
H. zero defects

9. What are the goals of Statistical Process Control?

10. What are the employee's roles in SPC?

WHAT WILL STATISTICAL PROCESS CONTROL MEAN TO YOU IN THE PERFORMANCE OF YOUR JOB?

HOW WILL YOU AND CHAHTA BENEFIT BY USING SPC?

SESSION IV **CHAHTA QUALITY CONTROL**

COURSE OBJECTIVES:

Upon completion of this course, participants will be knowledgeable of the practices of Standardized Process Control; participants will be able to document inspection data and take appropriate actions based on documentation findings and criteria established by quality assurance.

SESSION OBJECTIVES:

At the conclusion of this session, participants will:

list ways they feel SPC will benefit them and the company

match words and phrases commonly used in relation to SPC and quality improvement with their meanings.

TIME	CONTENT	PROCESS/ ACTIVITY	MATERIALS
20 Min.	Review	Written individual exercise Group activity	"A Brief History of SPC" and "SPC: Main Idea Activity
15 Min.	Application to Job - WIIFM	Brainstorming Individual and Group Activity	
15 Min.	Glossary Use	Guided Discussion Individual Activity	Glossary of Term SPC Word Puzzle
10 Min.	Major Learning Points	Recap Major Learning Points	

SESSION IV CHAHTA QUALITY CONTROL

REVIEW

Use the handout entitled "A Brief History of SPC" and the worksheet entitled "Statistical Process Control: Main Idea Activity."

Provide instructions for this review activity:

They will be given about 8 minutes

to read and answer as many questions correctly as they can

answers to questions will not necessarily be in the same order that the questions are written

don't be overly concerned if you don't finish all the questions within the time allowed.

Allow participants time for the activity. After the time is up, divide the class into groups of 3 to 4. Allow them about 5 minutes to compare answers and complete any questions they may not have finished.

Ask participants how they went about finding the answers to the questions. Although some may have read the handout all the way through (which is OK) re-emphasize and reinforce the techniques used in reading for the main idea:

scanning
reading key sentences
looking for headings, bold type, etc.

Go through the activity with the class to be sure they have the correct answers, understand the information, and know how to read for main ideas. Answer any questions they may have.

APPLICATION TO JOB - WIIFM

Have participants brainstorm the question "What's In It For Me?" -- to list the benefits of implementation of a quality improvement process in their jobs. List the benefits they share on the flip chart. Briefly discuss the benefits they mention and any others you might add, with their consent.

Activity:

Allow participants about 5 minutes to answer the last two questions of the handout entitled "Statistical Process Control: Main Idea Activity." Then put them back into the groups they were in before and let them discuss the two questions for about 5 minutes.

Have each group report what they agreed on for each question.

The results should be that they see SPC and the move towards quality improvement as a positive step for themselves and the company because, among other things, it will:

provide products that exceed customer wants/needs

give them pride in the work they do

reduce production cost

reduce waste and rework

increase product sales

allow them an opportunity to have more control over what they do - they will know when to take initiative in correcting processes they are involved in

increase they skills

make work more rewarding

make Chahta a better place to work

SPC TERMS

Distribute handout entitled "Glossary of Terms Used in Statistical Process Control."

Guided Discussion:

Have participants look over the glossary and identify features which will help them use it. Inform them that a glossary is a form of dictionary. The features they should recognize are that words are listed alphabetically. They might also notice that words appear in bold type and that the word defined appears before its meaning.

Distribute the handout entitled "SPC Crossword Puzzle." Allow participants about 10 minutes to work on the puzzle.

Assign the rest of the puzzle to be completed before the next session.

RECAP MAJOR LEARNING POINTS

The Major Learning Points are:

Statistical Process Control (SPC is a quality improvement process.

The goals of SPC include

increased production
decreased cost of production
decreased waste and remakes
increased quality
improved work environment

SPC is designed to measure the process, not the operator.

Although SPC was used in the United States during World War II, it is Japan that has best implemented it in their industries.

World competition has increased the need to again concentrate on the quality of products, not merely the quantity.

Deming, Juran, Crosby, and Imai are all leaders in the quality control process. They have been successful in developing ideas and means through which industries can work toward meeting customer needs and continual improvement.

An SPC process is needed because of the fact that no two parts are identical and there is a need to control some factors to ensure that parts work well in the finished product.

Using the glossary to define how SPC terms are used will enable you to communicate with your co-workers and supervisors more easily.

GLOSSARY OF TERMS

USED IN STATISTICAL PROCESS CONTROL

attributes - information or specifications that can be checked and recorded.

Example: presence of a required label or installation of required fastener.

assignable cause - variation in a process caused by man, method, material, machine, or environment. It can usually be detected and removed.

chance cause - natural variation in a process that cannot be removed.

characteristic - features of a product.

control chart - a graph on which measurements of a characteristic are plotted. A control chart indicates how "well" your job is. They show you when your job is running satisfactorily or when something has gone wrong which needs correcting.

control limit - a line (or lines) on a control chart showing the farthest that a sample can be from the average and still be acceptable.

Variations beyond a control limit are evidence that the process is "out of control."

inspection - attempts to identify an unacceptable product after it has been produced.

population - all the possible measurements or objects.

prevention - actions taken to correct or improve the production process.

Prevention is consistent with a philosophy of never-ending improvement.

probability - measure of how likely it is that some event will occur.

process - the combination of people, machines, and equipment, raw materials, methods, and environment that produces a given product or service.

process capability - the measured, built-in reproductibility (consistency) of the product made. Process capability is made using statistical methods.

quality - meeting customer needs; doing things right the first time.

range - a measure of the variation in data.

raw data - when data are collected without being organized.

Example: 100 pistons written down as they are measured.

sample - part of the population that is measured or observed for the purpose of identifying characteristics and performance of all the products.

specification - the engineering requirement for judging whether a particular characteristic is acceptable or not.

Specifications are chosen with respect to functional or customer requirements for the product.

standard deviation - a measure of the spread of the product or process; what is considered "normal" for that product or process.

statistical process control - the use of statistical methods such as control charts to analyze a process or its product so that appropriate actions can be taken to improve the capability of the process.

variables - those characteristics of a part which can be measured.

Examples: length in millimeters; resistance in ohms; torque of a nut in foot pounds

variation - the inevitable difference among the parts produced in a process.

SESSION V **SPC, CHAHTA AND ME**

COURSE OBJECTIVES:

Upon completion of this course, participants will be knowledgeable of the practices of Standardized Process Control; participants will be able to document inspection data and take appropriate actions based on documentation findings and criteria established by quality assurance.

SESSION OBJECTIVES:

At the conclusion of this session, participants will:

explain the relationship of quality and quality control process to the jobs they perform

discuss the value of documentation

TIME	CONTENT	PROCESS/ ACTIVITY	MATERIALS
10 Min.	Review	Lecture	
20 Min.	SPC and Me	Individual Sharing	SPC and Me Handout
20 Min.	Importance of Documentation	Guided Discussion	
10 Min.	Major Learning Points	Recap Major Learning Points	Blank Paper

*SESSION V SPC, CHAHTA, & ME

REVIEW

Ask questions to review participants on the major learning points from the previous session. They were:

Statistical Process Control (SPC) is a quality improvement process.

The goals of SPC include:

increased production
decreased cost of production
decreased waste and remakes
increased quality

An SPC process is needed because of the fact that no two parts are identical and there is a need to control some factors to ensure that parts work well in the finished product.

SPC AND ME

Distribute the handout, "SPC and Me." Provide participants with the following instructions:

List the benefits you see as a result of implementing a process of inspections and documentation by workers

Write any questions you have about the process (or comments)

Allow about 10 minutes for participants to work on the exercise. After that, allow any who want to, to share their ideas with the group.

IMPORTANCE OF DOCUMENTATION

Ask questions so that participants will discover the value to Chahta and to themselves for doing documentation. You might begin by asking them if they ever had to prove they were entitled to drive an automobile to a policeman or to a patrolman?

Ask if the law officer would have merely accepted their word that they had a driver's license or did the officer have to be shown the license?

Ask the participants what value other than proof of having done the inspection does documentation serve. Refer them back to the example of the driver's license.

Possible responses might include:

provides a permanent record
information available to others who might need the information

Ask what happens now when they inspect a part. They will probably tell you that it the part is OK, they don't do anything. Some will tell you that it the part doesn't meet standards, they inform their supervisors. Some might even be going ahead and taking corrective actions.

Then, ask how do they keep up with how well they are doing? Do they have any way of going back and showing that they did examine a certain number of parts, how many of those were good and how many parts were taken out because they didn't meet specifications? Chances are they would have to guess at the answers to these questions.

Explain that when there is documentation - control charts have been used - actions can be taken that will actually prevent defects from being produced. When problems begin, they will be recognized immediately and corrective actions taken, so fewer parts will have to be remade and less materials will be wasted.

Emphasize the importance of documentation as an employee, by asking: Why is it important to them to help Chahta save time and money on reworking defective parts and decreasing waste. They should come up with answers that would include:

* waste and reworking increases production costs
* production costs increase consumer costs
* consumers are looking for quality products at the lowest possible cost
* the lower the cost of a quality product, the more likely consumers are to purchase the product
* it's just as easy, if not easier, to do things right the first time as it is to remake them
* high production costs lead to decreased sales and profits; which could be turned into employee benefits
* pride in the work one does and in the product one helps to produce.

MAJOR LEARNING POINTS

Distribute a blank piece of paper to each participant. Instruct them to list the five things they learned today they feel were important to them. (take the papers up as participants leave, to use as a review in the next session) Major points:

SPC is important to Chahta

Employees are an important part of SPC and the quality improvement process at Chahta.

SESSION V

SPC AND ME

Individual Written Summary

List the benefits you see as a result of implementing a process of inspections and documentation by workers.

Write a brief summary of what you think are the reasons why Chahta is so interested in Statistical Process Control?

Write any questions or comments you have about the process.

SESSION VI PRINCIPLES OF SPC

COURSE OBJECTIVES:

Upon completion of this course, participants will be knowledgeable of the practices of Standardized Process Control; participants will be able to document inspection data and take appropriate actions based on documentation findings and criteria established by quality assurance.

SESSION OBJECTIVES:

At the conclusion of this session, participants will:

list and explain the basic principles of SPC,

define variation and list possible cause of variation in manufacturing,

identify ways in which variations in products can be measured.

TIME	CONTENT	PROCESS/ ACTIVITY	MATERIALS
10 Min.	Review & Overview	Guided Discussion Lecture	Lists from Session V Objectives
25 Min.	Principles of SPC	Individual & Group Activity	Principles of SPC
20 Min.	Variations	Guided Discussion	Two similar objects sample parts
5 Min.	Major Learning Points	Recap Major Learning Points	

SESSION VI PRINCIPLES OF SPC

REVIEW

Use participant's lists submitted at the conclusion of the previous session. Allow participants to add other major points, if needed, so that the following topics are reviewed:

SPC - a form of quality improvement. It will be implemented at Chahta.

Management places a great deal of importance on the quality process and recognizes the vital role employees perform in the process.

Employees are an important part of SPC and the quality improvement process at Chahta.

OVERVIEW

Use the flip chart or board to list the agenda for this session. Objectives are:

List and explain the basic principles of SPC
Define variation and list possible causes of variation in manufacturing
Identify ways in which variations in products can be measured.

PRINCIPLES OF SPC

Distribute copies of the handout entitled "Principles of SPC."

Instruct participants to read the handout. After reading it, they are to list the six basic principles and write a one (1) sentence summary or description of each concept.

Allow about 10 minutes for participants to work on the activity. Then, divide the class into groups of 2 or 3 for 5 minutes. Continue the activity with the groups. Each group is to come up with one list and set of statements.

Debrief the activity by allowing each group to present it summary. From their summaries, compose a group summation of the six basic principles of SPC (use a flip chart or blackboard). Have participants copy this information.

VARIATIONS - is the inevitable difference among the parts produced in a process.

Guided Discussion: Hold up two things which are almost alike, such as apples, oranges, or pencils of different lengths. Ask how the pieces are similar. Then ask how they are different. Explain that variation is a natural law -- it is not possible for two things to be exactly alike.

Ask someone to give an example of the fact that variations are a natural law. Possible examples could be:

Twins
fruit or vegetables
leaves or blades of grass

Relate this to industry by asking them about the variations they see everyday on the job. Begin this discussion by asking participants to define variations. Then ask how they see variations in their jobs. These could include differences in:

parts they produce
equipment
raw materials (size, color, gauge, length, width, and depth)
procedures they follow in manufacturing similar parts (everyone does it a little differently)

Hold up an approved samples of any component of the wire harness. Hold up a second sample.

Ask first how the parts are similar. Then, ask how they are different.

(Instructor: be sure to use a part with a visible enough difference for participants to notice.)

Explain that most certified specifications are given in ranges because of the fact that no two parts are identical. This allows for the degree of acceptable difference. As long as a measurement is within the range specified, the part will work for the purpose it was being produced.

VARIATIONS - MEASURABLE

Ask participants to tell how they would describe differences in the items they had listed earlier.

They should mention such things as:

twins - birthmarks, freckles, movements, coloring, eyes, etc.

fruits or vegetables - color of peeling, shape, size

leaves or blades of grass - length, markings, veins, stems, etc.

Ask how they can detect and describe variations in the parts they produce on the job. They should name features including:

color
size
weight
dimensions

Restate the first principle of SPC - no two things are alike.

Explain that because there are differences and some differences do not affect the part's ability to perform as it should, it is important to be able to determine when a part would not be acceptable.

Emphasize that variations are generally managed by inspections to measure critical dimensions.

Variations are measured by:

1. inspection
2. ruler
3. caliper
4. micrometer
5. theometer???
6. gauge
7. plotting (chart)
8. calculator

Common Causes of Variation

1. differences in raw materials
2. slight vibration of machines
3. no two people do anything exactly alike
4. human error in reading instruments

Assignable Causes: Special

1. faulty set up
2. worn tools
3. dies not exactly right
4. untrained operator

MAJOR LEARNING POINTS

Recap Major Learning Points by asking participants to tell you what they learned during this session. Among the things they should list, are:

Variations are a natural part of SPC. This tells us that differences between individual parts are normal and SPC charting takes this fact into consideration by the normal curve plotted when a process is documented.

Because variations are natural, they are allowed for in the manufacturing process.

Common Causes of Variations:

1. variations in raw material
2. slight vibrations of machines

Causes of Variations

1. Machine gets slightly or slowly out of order
2. No two people handle a machine exactly alike
3. differences in gauge (or size) of wire
4. untrained operator
5. faulty set-up
6. worn tool
7. human error in reading instruments or setting controls

PRINCIPLES OF SPC

1. No two things are exactly alike.

2. Variation can be measured.

3. Variation forms a definite pattern.

4. Large groups of measurements will cluster toward the middle.

5. The shape of the distribution curve can be predicted.

6. Variations due to assignable causes distort the normal curve.

PRINCIPLES OF SPC

In manufacturing, operators are constantly trying to make parts that meet customer demands. They are also trying to make each part as much alike as possible. This can only be accomplished by keeping control of your operation. Calipers, gauges, etc. measure dimensions, but statistical quality control methods will give you tools to measure the performance of an operation in a way it can be shown to others.

Statistical process control is based on six basic principles. Those are:

1. **No two things are exactly alike.** Regardless of how hard manufacturers try to make parts alike; there are always differences in shape, size, or finish from other parts. For parts to be interchangeable the differences must be kept as small as possible. This is done by the second principle.

2. **Variation in a product process can be measured.** Variation in your job is normal. As variations increase processes will go "down-hill" if they are not watched carefully. Therefore it is necessary to measure the output of processes. As processes are monitored the third principle becomes obvious.

3. **Things vary according to a definite pattern.** The pattern that develops is called the frequency distribution curve. This curve is bell shaped, with more measurements or numbers around the middle and fewer as you move from the center. This curve will repeat itself whenever you take groups of measurements, which leads to the fourth principle.

4. **Whenever things of the same kind are measured, a large group of the measurements will tend to cluster around the middle.** Most measurements will be close to the middle. This allows mathematicians to fairly accurately predict the percentage of measurements in various sections of the frequency distribution curve. This curve is known as the normal distribution curve. Which brings us to the fifth principle.

5. **It is possible to determine the shape of the distribution curve for parts produced by any process.** By making a frequency distribution chart of the pieces produced and comparing those measurements with the blue print specifications we can learn what the process is doing. Then that can be compared with what we want the process to do. If the process is no doing what it should, then we can make changes. This is done by looking for causes for variations.

If variations in the process are due to chance or normal causes alone the product will vary in a normal, predictable manner. If any unusual changes occur, this change will also show up in our normal distribution curve. The result is said to be the result of an

assignable or special cause and not chance causes alone. Assignable causes will cause the normal distribution curve to lose its normal bell shape, which brings us to the sixth basic principle.

6. **Variations due to assignable causes tend to distort the normal distribution curve.** A frequency distribution curve helps us to determine whether chance causes alone exist in a process or it assignable causes are also present.

SESSION VII PRINCIPLES OF SPC (2)

COURSE OBJECTIVES:

Upon completion of this course, participants will be knowledgeable of the practices of Standardized Process Control; participants will be able to document inspection data and take appropriate actions based on documentation findings and criteria established by quality assurance.

SESSION OBJECTIVES:

At the conclusion of this session, participants will:

relate why inspection is important in the manufacturing process

replicate the normal pattern developed when there are no special causes for variation.

TIME	CONTENT	PROCESS/ ACTIVITY	MATERIALS
10 Min.	Review and Overview	Lecturette	Review the Major Learn-Points from last session Session Objectives
10 Min.	Importance of Inspection	Guided Discussion	
10 Min.	Variations Form Patterns	Lecture	Probability
20 Min.	Penny Toss & Bell Curve	Group Activity	Pennies
10 Min.	Major Learning Points	Recap Major Learning Points	

SESSION VII PRINCIPLES OF SPC (2)

REVIEW

For review purposes, discuss the major learning points from the previous session. These include:

Variation are a natural part of SPC. This tells us that differences between individual parts are normal and SPC charting takes this fact into consideration by the normal curve plotted when a process is documented.

Because variations are natural, they are allowed for in the manufacturing process.

OVERVIEW

See objectives for this lesson, for the overview.

IMPORTANCE OF INSPECTION

Guided Discussion: Ask participants to think about a time they were producing something that didn't come out right. Ask for a couple of examples. The ask what might have been done to prevent the mistakes from being made.

They should come up with ideas that if steps in the constructions had been looked at more carefully and small corrections made along the way, the outcome might have been very different.

Summarize the discussion by explaining that inspecting, even little things, along the way can make a real difference in the outcome of a product.

Have participants relate this to their jobs. They should come to the conclusion that random inspections and corrective actions taken immediately will lead to better quality products for Chahta.

Summarize this principle by explaining how inspections are the means through measurements are taken to determine that the variations among parts are kept within the range of certified specifications. This will also alert an operator when unacceptable variations occur.

VARIATIONS FORM PATTERNS

Explain the concept that a predictable pattern is formed when a manufacturing process is operating and there are no circumstances out of the ordinary occurring. This is true due to the laws of probability.

Probability
Distribute the handout entitled "Probability". Briefly discuss the explanation and examples on the worksheet. Have participants complete the exercise section by themselves.

Allow about 5 minutes. Go through the questions with them.

Divide the participants into groups of 2. Distribute ten pennies and one handout entitled "Penny Toss" to each pair. Provide them with the following instructions:

> One of them is to toss the 10 pennies
>
> The other is to record on the work sheet, the number of times heads turns up during the 10 tosses.

Have them repeat the process 9 more times, so that in all they will have tosses the 10 pennies 10 times, or 100 penny throws, with each time recording the number of times heads turned up.

Plot the Tosses
When participants have completed their tosses, have them tell you how many times the heads turned up for each of their series of 10.

(While participants are tossing the pennies, you can prepare, on the flip chart or blackboard, a chart. Draw a horizontal line, numbered 0 to 10, to reflect the possible number of times heads could have come up on each toss.)

Example: If the first toss recorded in round one, HEADS appeared 5 times, you should place an "X" in the space above the number 5. If the second toss was 4, place an "X" in the space above the 4; if in the third round they toss heads 5 times, place an "X": in the next available space above the number 5, etc.

Bell Curve

After plotting, participants should be able to see how the Bell curve would begin to develop. Explain that this is known as the normal frequency curve. Some will be familiar with the idea of a teacher grading on the curve - which is an example of this idea put into practice.

They may begin to see the central limit theorem - the more measurements taken, the closer they will cluster to the middle points. This principle will be discussed in the next session.

RECAP MAJOR LEARNING POINTS

Ask participants to tell you what they learned during this session. Among the things they list, should be:

Because variations are natural, they are allowed for in the manufacturing process.

This is evidenced in the ranges provided with most certified specifications.

Variations must be kept within the acceptable range. This is managed by inspecting critical dimensions.

The laws of probability tell us that there are certain things that will tend to occur and the frequency in which they will tend to occur. Both probability and frequency are important in determining the variation which will be tolerated in a part.

SESSION VII

PENNY TOSS

DIRECTIONS:

Take 10 pennies.
Toss them.
Record how many head are showing.
Repeat the process 9 times.

How many times did you get heads? Use tally marks on the chart below to show how many heads showed each time the 10 pennies were tossed.

FREQUENCY TALLY

1.

2.

3.

4.

5.

6.

7.

8.

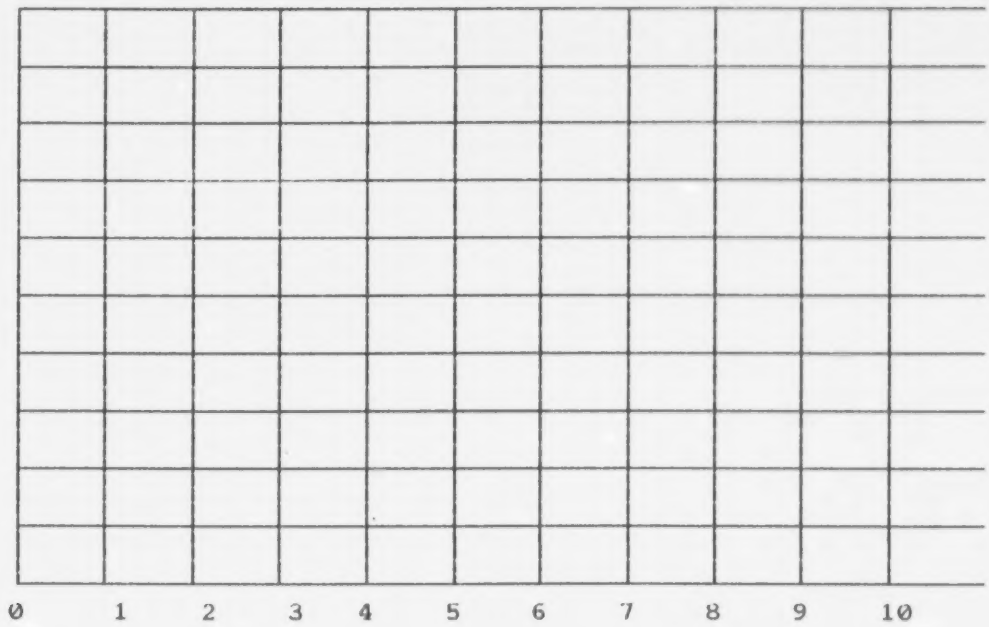
9.

10.

SESSION VII

PENNY TOSS
FREQUENCY DISTRIBUTION
CHART

Number of Times
Toss Occurred



Possible Number of Times
Heads Might Appear

PROBABILITY

The concept of probability is very important to manufacturing operations which use statistical process control. Probability estimates can, with a high degree of certainty, predict production outcomes.

Why Probability Is Important To SPC

It is usually impossible to perform 100 percent inspections on all parts that go into a battery. To ensure that the design specifications are being met and that the batteries are operating properly, manufacturers use limited information gained from the inspection of a few of the parts. From these random sampling they can make judgements about an entire batch of parts or about the process that produces them.

Probability Theory

The probability theory is the glue that holds all the parts of the inspection together. To be sure that a process is in control and functioning according to expectations, company rules for inspection and sampling must be followed. As GNB implements SPC throughout the plant, specific rules for sampling and measuring will be developed. Following these rules will be critical to control quality.

Examples of Probability

We often hear statements such as:

"There is a 20% chance of rain today."

"The Florence division of GNB has a 99% chance of being the U.S. leader in quality batteries in 1991."

There are estimates of the changes that the above events will occur. The probability of an event is a number describing the chance that event will actually happen.

If you take a screw from a box that contains only screws, you are certain to get a screw. The probability of that happening is 1.

It would be impossible to take a wire out of that same box. The probability of an impossible event is Ø.

If an event is not impossible or certain, the probability is between Ø and 1.

SESSION VII

FINDING PROBABILITIES

To pick the day to go grocery shopping, you close your eyes and mark and X on a weekly calendar. There are seven possible outcomes, the days from Sunday through Saturday.

Since Thursday is one of the seven outcomes, the probability of picking Thursday is 1 out of 7, or 1/7. This can be written as follows:

$$P(\text{Thursday}) = 1/7$$

There are two weekend days, Saturday and Sunday.
P(weekend day) = 2/7 P(week day) = 5/7

If all the outcomes are equally likely, we use a formula to find probabilities.

$$\text{Probability} = \frac{\text{number of favorable out comes}}{\text{total number of outcomes}}$$

EXERCISES:

1. You have a coin. What is the probability of flipping it and getting TAILS? $P = \frac{1}{2}$

2. You have a deck of 52 cards. What is the probability of getting the 3 of spades? $P = \frac{1}{52}$

3. What is the possibility of getting a 3 from that same deck of cards? $P = \frac{4}{52}$

SESSION VIII PRINCIPLES OF SPC (3)

COURSE OBJECTIVES:

Upon completion of this course, participants will be knowledgeable of the practices of Standardized Process Control; participants will be able to document inspection data and take appropriate actions based on documentation findings and criteria established by quality assurance.

SESSION OBJECTIVES:

At the conclusion of this session, participants will:

demonstrate the concept that the more samples tested the more results will cluster toward the middle of the normal curve.

discuss the predictability of control charts when process has no assignable cause of variation.

distinguish between common and assignable causes of variation, and recognize how assignable cause distorts the natural curve and control charts.

define control charts and identify the value of the role they play in SPC.

TIME	CONTENT	PROCESS/ ACTIVITY	MATERIALS
10 Min.	Review and Overview	Guided Discussion	Principles of SPC
15 Min.	Cluster Towards the Middle	Group Activity	Pennies
15 Min.	Penny Toss	Plot Tosses	Frequency Chart
5 Min.	Predictability of Process	Lecturette	Handout #1
10 Min.	Assignable Causes of Variation	Guided Discussion	Handouts #1 & #2
5 Min.	Major Learning Points	Individual Activity	Principles of SPC

SESSION VIII PRINCIPLES OF SPC (3)

Review & Overview

Have participants review the handout, "Principles of SPC". Ask them to review the major points they learned about the first three principles, which should include the following points:

Variations are a natural part of SPC. They tell us that differences between individual parts are normal, and SPC charting takes this fact into consideration by the normal curve plotted when a process is plotted.

Because variations are natural they are allowed for in the manufacturing process. This is evidenced in the ranges provided with most certified specifications.

Variations must be kept within the acceptable range -- this is managed by inspecting critical dimensions.

Probability tells us that there are certain things that will tend to occur and the frequency in which they will tend to occur. Both probability and frequency are important in determining the variations which will be tolerated in a part.

Have participants reread the six principles of SPC.

Write on the blackboard and briefly discuss the objectives for this session.

MORE SAMPLES CLUSTER TOWARD THE MIDDLE
PREDICTABILITY OF CONTROL CHARTS
COMMON AND ASSIGNABLE CAUSES OF VARIATION

CLUSTER TOWARDS THE MIDDLE

Remind participants of the fourth principle of SPC:

"Whenever things of the same kind are measured, a large group of the measurements will tend to cluster around the middle."

Penny Toss. Remind participants of the penny toss they did the previous week and how the bell curve was formed. Go on to explain how that, as more and more tosses are made, more and more results should be toward the middle of the curve, eventually distorting the curve.

Tell the group that to demonstrate this concept, you are going to have them continue the penny toss and add this session's tosses with those of previous session. Divide participants into groups of 2. Distribute 10 pennies and the handout, "Penny Toss" to each group. Remind them of the instructions:

toss the 10 pennies

one is to record, on the work sheet, the number of times Heads turns up during the 10 tosses

repeat the process 9 more times, so that in all they will have tossed the penny 100 times and each time they are to record the number of time heads turns up.

When participants have completed their tosses, have them tell you how many times HEADS turned up for each of their series of 10. Plot this on the chart you had in the previous session -- adding this data to the data collected in the previous class. They should begin to see how the Bell curve begins to become distorted.

PREDICTABILITY OF PROCESS

Explain the Central limit theorem:

> "the more measurements taken, the closer they will cluster to the middle points"

Explain that the normal distribution (Bell Curve) and the central limit theorem are the results of taking information from control charts and plotting them on a graph. And, that unless circumstances or events out of the ordinary occur, this is what will always happen.

Pass out sample charts that are in control, Handout #1.

Explain that these demonstrate the law of probability, and what makes manufacturing a sure and safe thing as long as a process is monitored and remains in control. It is when special or assignable variations occur that the process gets out of control. This will be noticed by defective products as well as showing up on control charts.

ASSIGNABLE CAUSES OF VARIATION DISTORT PATTERNS

Distribute the handout, #2 - "Common and Assignable Causes of Variation." Review the definitions of common and assignable causes of variation. Have participants give examples of each, first for everyday events, which could include anything they make allowances for:

time for coffee to brew
time for getting dressed in the morning
waiting time to get out of the parking lot

Individual Exercise
Have participants complete the exercise. They are to:

write a "C" in the space beside common causes of variation

write an "A" in the space beside assignable causes

Refer back to Handout #1 to show a normal distribution curve, to demonstrate what takes place when a process is in control.

Use the 2nd and 3rd sample charts from Handout #1 to show a control chart when an assignable cause is present. Explain that this is what happens when the data from control charts is put into graph form. Inform participants that you will discuss this in more detail in a later lesson.

MAJOR LEARNING POINTS

Recap Major Learning Points by distributing the worksheet entitled "Principles of SPC Review". Explain that this is for a review of the six basic principles of SPC. Allow them to use any materials they have with them to answer the questions in the activity.

(Instructor would keep this activity to give back to participants as a review at the beginning of the next session. But, after the next session, take it up for placement in the participant's file as a record of their work.)

SESSION VIII

PENNY TOSS

DIRECTIONS:

Take 10 pennies.
Toss them.
Record how many head are showing.
Repeat the process 9 times.

How many times did you get heads? Use tally marks on the chart below to show how many heads showed each time the 10 pennies were tossed.

FREQUENCY TALLY

1.

2.

3.

4.

5.

6.

7.

8.

9.

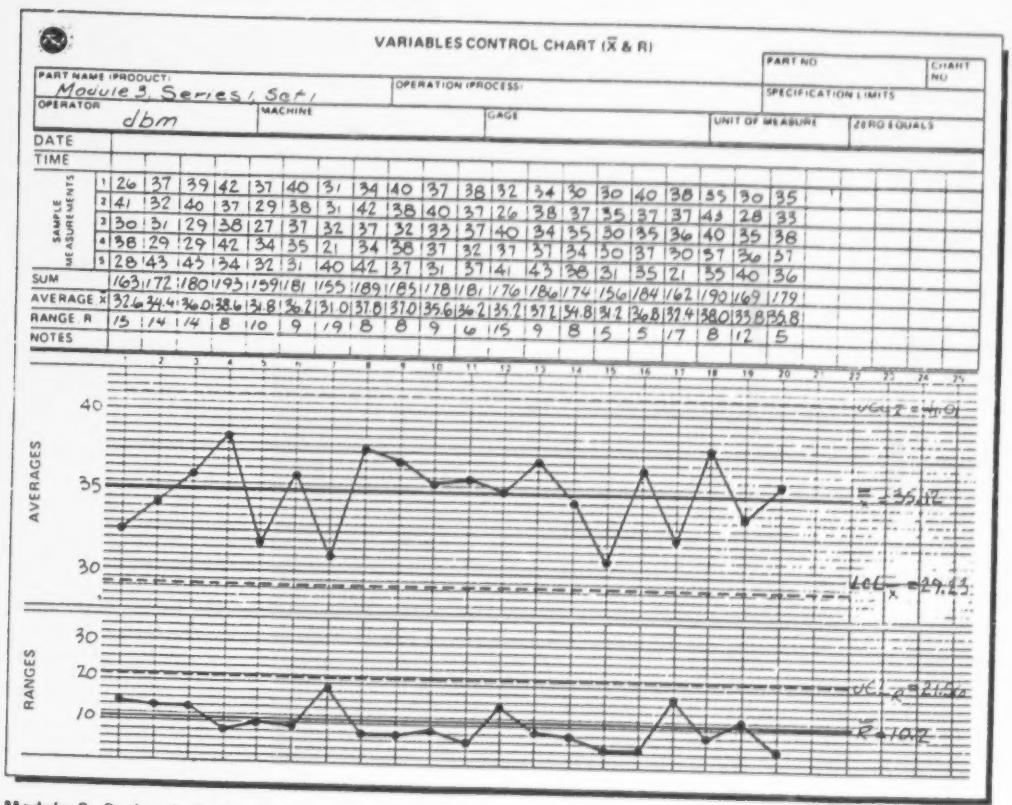
10.

SESSION VIII

8–9. *See the answer charts.*

10. (a) Set 1: No.
Set 2: No.
Set 3: Yes, one.
Set 4: No.

(b) Set 1: Use the control charts in production.
Set 2: Use the control charts in production.
Set 3. Remove the one point; recalculate the control limits for $\bar{X}$'s.
Set 4: Use the control charts in production.



VARIABLES CONTROL CHART ($\bar{X}$ & R)

PART NAME (PRODUCT): Module 3, Series 1, Set 1 | OPERATION (PROCESS): | PART NO | CHART NO | SPECIFICATION LIMITS

OPERATOR: dbm | MACHINE | GAGE | UNIT OF MEASURE | ZERO EQUALS

DATE																					
TIME																					
SAMPLE MEASUREMENTS 1	26	37	39	42	37	40	31	34	40	37	38	32	34	30	30	40	38	35	30	35	
2	41	32	40	37	29	38	31	42	38	40	37	26	38	37	35	37	37	43	28	33	
3	30	31	29	38	27	37	32	37	32	33	37	40	34	35	30	35	36	40	35	38	
4	38	29	29	42	34	35	21	34	38	37	32	37	37	34	30	37	30	37	36	37	
5	28	43	43	34	32	31	40	42	37	31	37	41	43	38	31	35	21	35	40	36	
SUM	163	172	180	193	159	181	155	189	185	178	181	176	186	174	156	184	162	190	169	179	
AVERAGE $\bar{X}$	32.6	34.4	36.0	38.6	31.8	36.2	31.0	37.8	37.0	35.6	36.2	35.2	37.2	34.8	31.2	36.8	32.4	38.0	33.8	35.8	
RANGE R	15	14	14	8	10	9	19	8	8	9	6	15	9	8	5	5	17	8	12	5	
NOTES																					

AVERAGES: 40, 35, 30 — $\bar{\bar{X}}$ = 35.16, LCL$_{\bar{X}}$ = 29.23

RANGES: 30, 20, 10 — UCL$_R$ = 21.70, $\bar{R}$ = 10.7

Module 3, Series 1, Set 1. Average and range chart.

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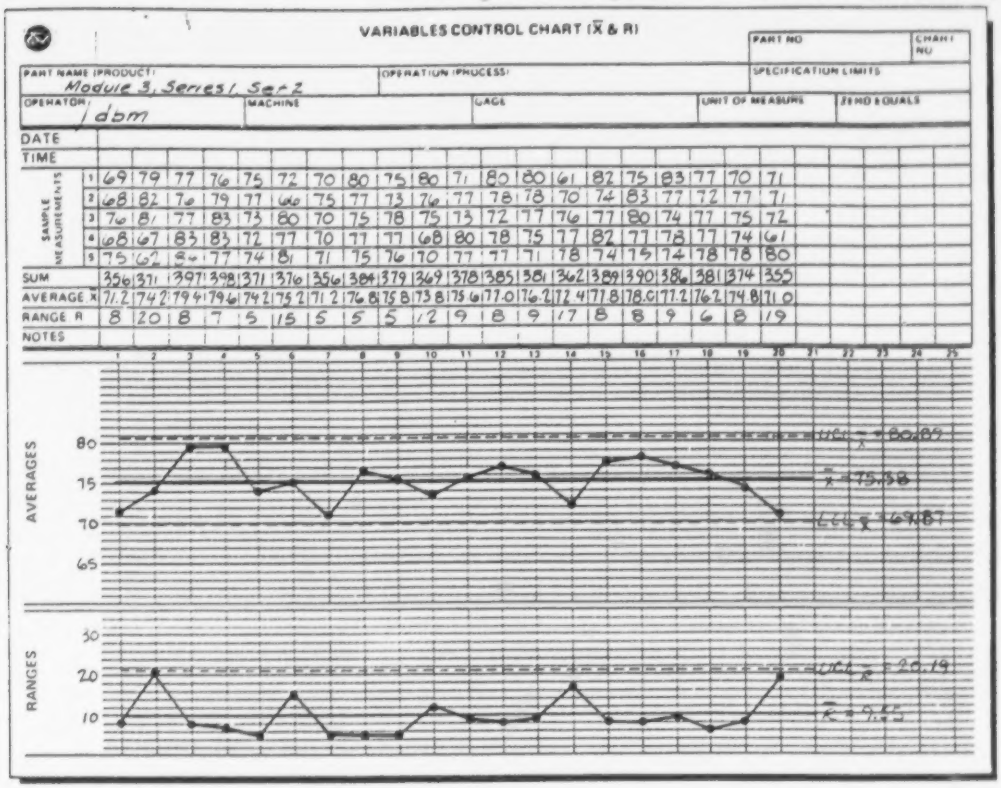


VARIABLES CONTROL CHART ($\bar{X}$ & R)

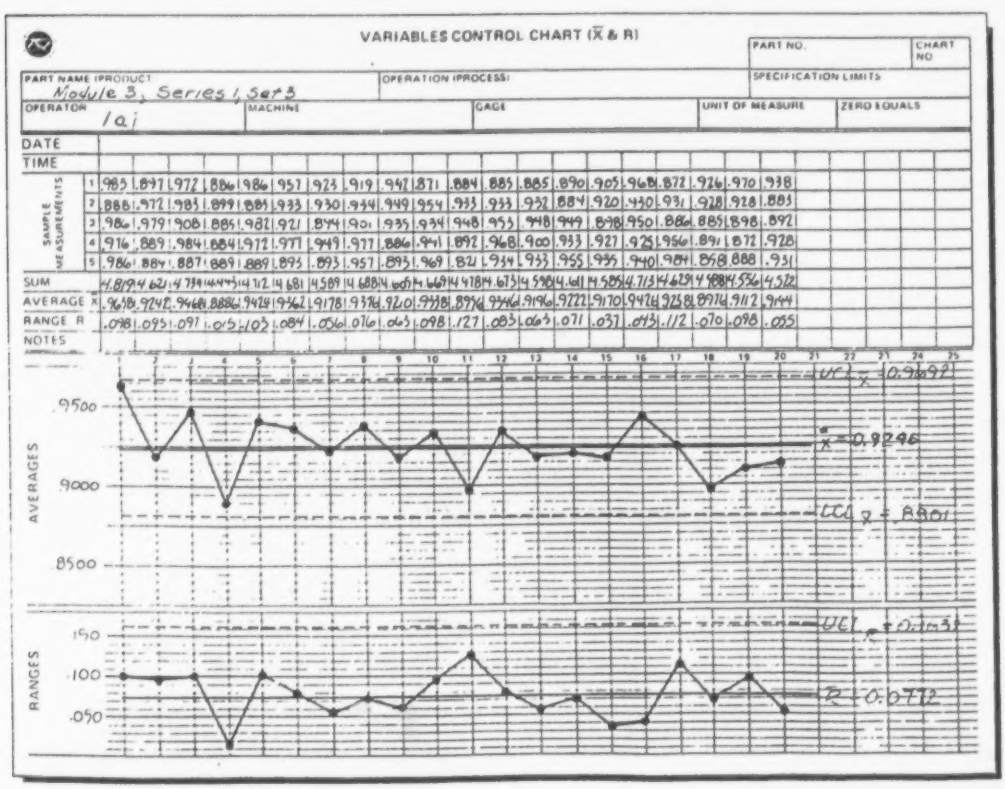
PART NO | CHART NO

PART NAME (PRODUCT): Module 3, Series 1, Set 2 | OPERATION (PROCESS) | SPECIFICATION LIMITS

OPERATOR: dbm | MACHINE | GAGE | UNIT OF MEASURE | ZERO EQUALS

DATE																				
TIME																				
SAMPLE MEASUREMENTS 1	69	79	77	76	75	72	70	80	75	80	71	80	80	61	82	75	83	77	70	71
2	68	82	76	79	77	66	75	77	73	76	77	78	78	70	74	83	77	72	77	71
3	76	81	77	83	73	80	70	75	78	75	73	72	77	76	77	80	74	77	75	72
4	68	67	83	83	72	77	70	77	77	68	80	78	75	77	82	77	78	77	74	61
5	75	62	80	77	74	81	71	75	76	70	77	77	71	78	74	75	74	78	78	80
SUM	356	371	397	398	371	376	356	384	379	369	378	385	381	362	389	390	386	381	374	355
AVERAGE $\bar{X}$	71.2	74.2	79.4	79.6	74.2	75.2	71.2	76.8	75.8	73.8	75.6	77.0	76.2	72.4	77.8	78.0	77.2	76.2	74.8	71.0
RANGE R	8	20	8	7	5	15	5	5	5	12	9	8	9	17	8	8	9	6	8	19
NOTES																				

Module 3, Series 1, Set 2. Average and range chart.



VARIABLES CONTROL CHART ($\bar{X}$ & R)

PART NO. | CHART NO

PART NAME (PRODUCT): Module 3, Series 1, Set 3 | OPERATION (PROCESS) | SPECIFICATION LIMITS

OPERATOR: aj | MACHINE | GAGE | UNIT OF MEASURE | ZERO EQUALS

DATE																				
TIME																				
SAMPLE MEASUREMENTS 1	.983	.897	.972	.886	.986	.957	.923	.919	.947	.871	.884	.885	.885	.890	.905	.968	.872	.926	.970	.938
2	.888	.972	.983	.899	.885	.933	.930	.934	.949	.954	.933	.933	.937	.884	.920	.930	.931	.928	.928	.885
3	.986	.979	.908	.885	.982	.921	.894	.901	.935	.934	.948	.955	.948	.949	.878	.950	.886	.885	.898	.892
4	.916	.889	.984	.884	.972	.977	.949	.977	.886	.941	.892	.968	.900	.933	.927	.925	.956	.891	.872	.928
5	.986	.884	.887	.889	.889	.893	.893	.957	.893	.969	.821	.934	.933	.955	.935	.940	.984	.858	.888	.931
SUM	4.819	4.621	4.734	4.443	4.712	4.681	4.589	4.688	4.610	4.669	4.484	4.675	4.603	4.611	4.585	4.713	4.629	4.488	4.556	4.574
AVERAGE $\bar{X}$	.9638	.9242	.9468	.8886	.9424	.9362	.9178	.9376	.9220	.9338	.8968	.9346	.9196	.9222	.9170	.9426	.9258	.8974	.9112	.9144
RANGE R	.098	.095	.097	.095	.105	.084	.056	.076	.065	.098	.127	.083	.067	.071	.037	.045	.112	.070	.098	.055
NOTES																				

Module 3, Series 1, Set 3. Average and range chart.

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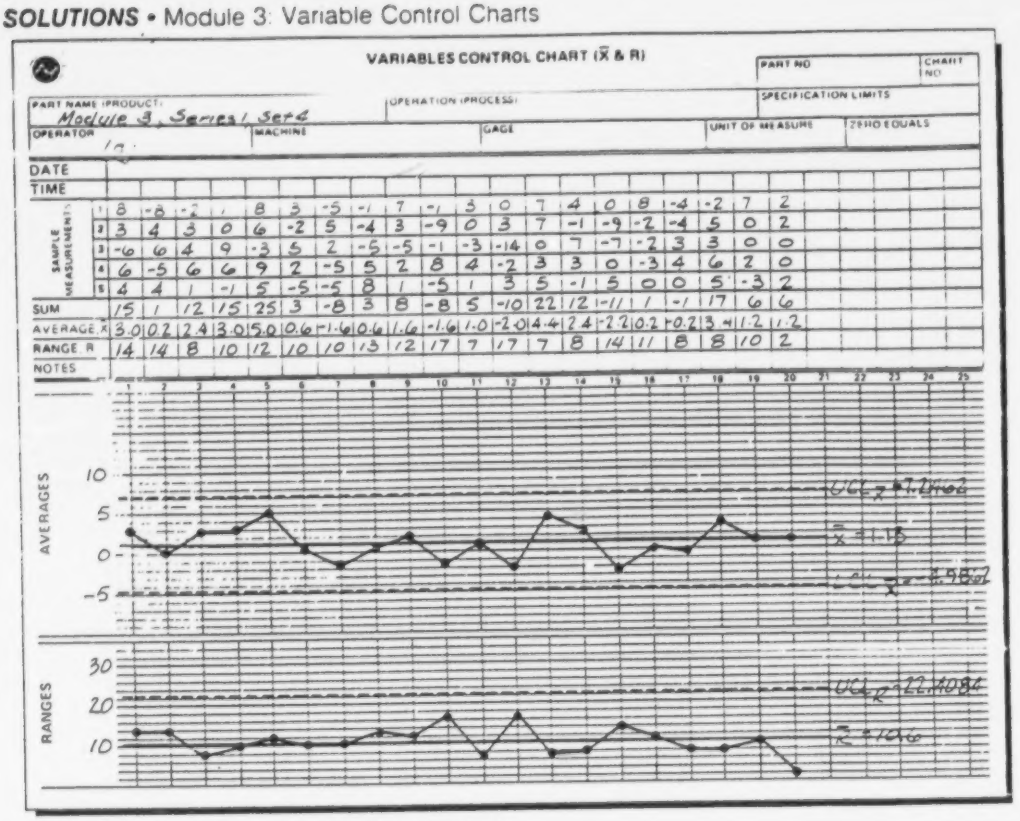
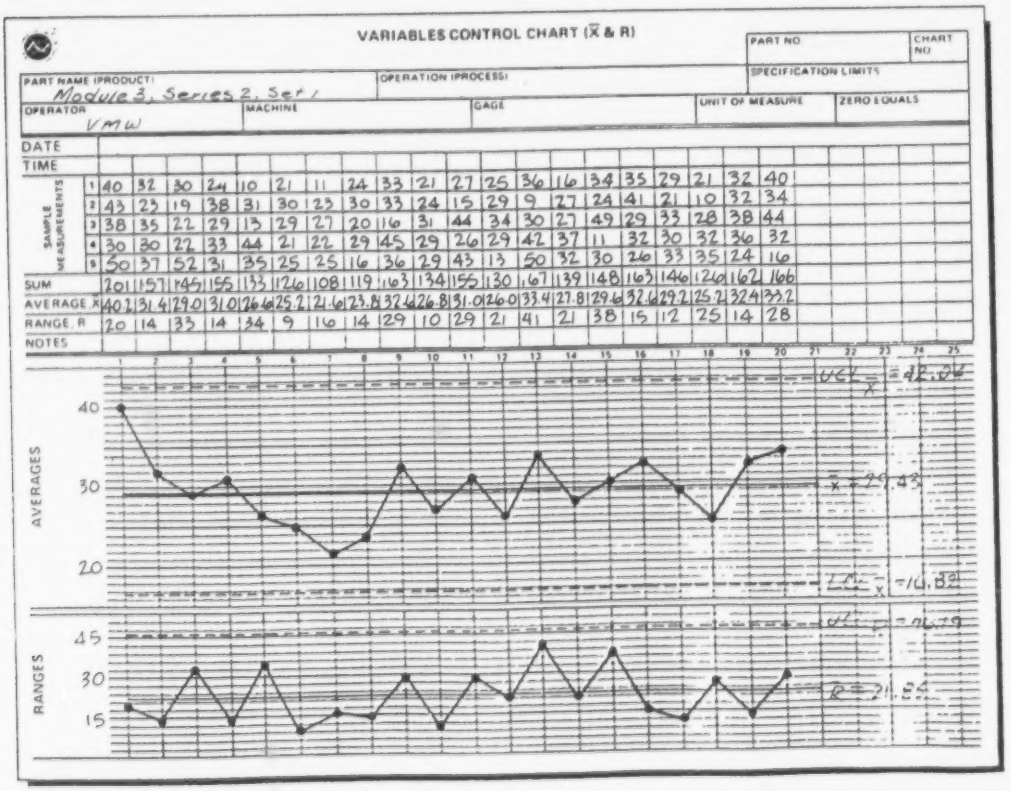


Module 3, Series 1, Set 4. Average and range chart.



Module 3, Series 2, Set 1. Average and range chart.

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COMMON AND ASSIGNABLE CAUSES OF VARIATION

The two major types of variation are:

common - those things that happen and are planned for and taken into account in SPC

assignable - things that happen that are unexpected, not taken into account and when they occur must be investigated

Put a "C" in the blank beside the cause listed below which would be considered a common cause; put an "A" beside the cause considered to be assignable causes.

_____1. Variations in raw materials

_____2. Slight vibration of machine

_____3. Untrained operator

_____4. Faulty set-up

_____5. Human error in reading instrument or setting controls

_____6. Worn tool

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C 1. Variations in raw materials

C 2. Slight vibration of machine

A 3. Untrained operator

A 4. Faulty set-up

C 5. Human error in reading instrument or setting controls

A 6. Worn tool

SESSION VIII

PRINCIPLES OF SPC: REVIEW

True or False - mark the true statements "+" and the false statements "O".

_____ 1. Because of machines making parts, there is no difference between any two parts made from the same machine.
_____ 2. Manufacturers are constantly trying to meet customer demands and expectations.
_____ 3. Even though there are differences in every part produced, they can still be interchangeable if the differences are kept small.
_____ 4. The way to keep parts as much alike as possible, is through controlling processes and operations within an industry.
_____ 5. Variation is not a normal occurrence.

_____ 6. The frequency distribution curve shows the normal pattern of how variations look.
_____ 7. The frequency distribution curve looks like a straight line with small lumps in it at several places.
_____ 8. The frequency distribution curve will lose its shape as more and more parts are measured and recorded, because if a process is going well the measurements will tend to cluster toward the middle.
_____ 9. Because the shape of the normal distribution curves can be predicted, it is possible to tell when something out of the ordinary happens.
_____ 10. Common causes will make the normal distribution curve and a process do very different things than it usually does.
_____ 11. The probability theory says that we will never be able to tell what might happen next.
_____ 12. Assignable causes are things that happen which are unexpected.

_____ 13. Control charts are a tool for collecting and presenting data about what is happening in a manufacturing process.
_____ 14. The primary purpose of control charts is to control the process so that defects are stopped before they occur.
_____ 15. Control charts can only measure characteristics which can be measured with precision instruments.

SESSION IX CONTROL CHARTS & METRIC SYSTEM

SESSION OBJECTIVES:

At the conclusion of this session, participants will:

be familiar with the different types of control charts used in SPC,

be able to understand the metric system.

TIME	CONTENT	PROCESS/ ACTIVITY	MATERIALS
10 Min.	Review and Overview	Guided Discussion	"Principles of SPC"
20 Min.	Control Charts	Guided Discussion	Handouts #1 & #2
20 Min.	Metric System	Guided Discussion	Handout #3
10 Min.	Major Learning Points Variation	Recap Major Learning	Handouts #1, #2, & #3

SESSION IX CONTROL CHARTS & METRIC SYSTEM

REVIEW

Use the worksheet, "Principles of SPC" as a review of the previous lesson.

OVERVIEW

Lesson objectives include:

participants becoming familiar with the different types of control charts used in SPC

participants being able to understand the metric system

CONTROL CHARTS

Ask participants what they recall from a previous discussion on the value of documentation. They should recall that it will allow other s access to information. This is part of the role of control charts.

Remind participants that in previous sessions the variations that are part of manufacturing have been discussed and that they have seen how these variations look when plotted on a control chart.

Explain that a valuable part of the quality control process is the inspection of parts being produced. The raw data collected as a result of inspections is what is documented on control charts.

Distribute the Handouts, "Types of SPC Charts" and "SPC Control Charts". Briefly review both handouts.

Discuss the two types of data collected for control charts:

Attributes - non-measurable characteristics of a part

Variables - measurable characteristics of a part

Distribute copies of various types of SPC charts used by the Quality Department of Chahta Enterprise.

Provide a brief explanation of the charts and the purpose they serve in quality control. Have participants identify the type of data collected on each chart. Emphasize that control charts can be used to collect either attribute or variable data.

The following information should be covered:

"P" Chart is used for plotting visual defects, for which the percentage of defective parts will be determined.

"NP" charts are used only when the number of samples inspected is always the same. It is used to record the number of defective parts.

The "C" charts record the number of defects per single part or unit. They are frequently used when more than one defect is possible with a part.

The X-R chart is probably the best known and most widely used control chart. It is an average and range chart designed to help you determine how your work is being done. The X bar shows the average of the samples inspected at any one time. The range shows the difference between the smallest and the largest sample inspected. This will let an operator recognize quickly when a process is out of control.

Note for Instructor: You should collect Chahta samples of the above types of charts. Have the Quality people give you an explanation of the data on the chart. If some of your participants have experience with the charts, let them give the explanation of the use of the charts.

THE METRIC SYSTEM

Pass out the Handout, "Metric System," to participants.

Briefly review with them the "Basic Principles of the Metric System." Give attention to the prefixes used in the metric system. Encourage questions from participants.

MAJOR LEARNING POINTS

Recap Major Learning Points by using the Handouts on SPC Charts and the Metric System.

SESSION IX

SPC CONTROL CHARTS

Control charts are used to collect and present data about a manufacturing process. The control chart enables you to monitor the machine and the material used for a particular job. To prevent the production of faulty products, workers are asked to fill out control charts at specific intervals.

One of the basic principles or manufacturing is that all parts have variations - no two parts are exactly alike. The causes of variations may be due to either chance or assignable causes. Chance variations seldom occur and when plotted on a control chart will not show trends, patterns, or cycles. Assignable cause variations show trends, patterns, cycles or runs when plotted over time. A control chart is used to show and control variations.

Control charts usually provide size limits for crucial parts. You can look at a chart and tell if the dimensions for a part are within the control limits.

Control charts also provide the Quality Control Department with statistics needed to know if machines are functioning correctly. These charts help workers to check a manufacturing process and to make adjustments to that process before faulty parts are made.

The primary use of control charts is to control the process so that defects are prevented from occurring.

TYPES OF SPC CHARTS

TYPE	INFORMATION PLOTTED	WHEN USED
P	% defective units	sample size varies
NP	number defective units	sample size constant
C	defect per unit	sample size constant
$\bar{X}$ R	variables and ranges	any time

There are two types of data collected for control charts:

1. Attributes - characteristics that are counted not measured. Attribute data only counts the number of rejects, but does not measure them. Attributes are used when measurements are difficult or impossible, such as defects caused by:
   - scratches
   - dents
   - color shading
   - finish smoothness
2. Variables - data collected by measuring features, such as:
   - length
   - weight
   - time
   - pressure
   - temperature

Variables are more like to lead to finding the causes of variation. However, not all characteristics are easily measured, judgments have to made about the acceptance or rejections of some parts.

SESSION IX

METRIC SYSTEM

The United States is the only major country which does not use the metric system as its standard for weights and measures. Because of modern means of travel, and increased dependance on imports and exports, most industries in the United States use the metric system.

Precision measurement is a constant companion of machine, hand, and assembly operations in industry. Most of the tools used at Homelite are based on the metric system.

Basic Principles of the Metric System

The metric system makes measuring and using measurements easier than the English system of inches, yards, pounds, etc. for several reasons:

1. measuring units are all based on 10. This is the same as our numbering system. This is based on the idea of counting objects in groups of 10. This makes measurements easier to convert to other measurements, and to write as decimals.

2. all the divisions of the basic units, or prefixes, are the same regardless of what you might be measuring. Although distance is measured in meters,

weight in grams, and liquid in liters, the prefixes of these are the same. Those prefixes are:

kilo = 1000 units

hecto = 100 units

deka = 10 units

deci = 0.1 unit (one-tenth of the unit

centi = 0.01 unit (one-hundredth of the unit)

milli = 0.001 unit (one-thousandth of the unit)

the most commonly used prefixes are:

kilo = 1000 units

centi = 0.01 unit (one-hundredth)

milli = 0.001 units (one-thousandth)

3. metric abbreviations are used just as with the English system. Drawings are of little value unless they contain dimensions. Since it would be time-consuming for the draftsman and would take too much space to print the words "inches" or "feet" after each dimension, symbols are used instead. In the English system of measurement the symbol for inches ", and ' for feet is used. In the metric system of measurements the words are even longer;

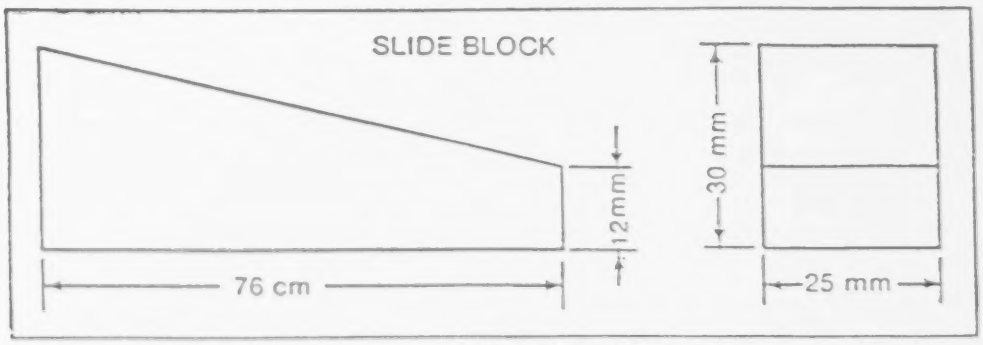
therefore, abbreviations are used throughout. The basic unit for lengths, the meter is abbreviated by using the small m. Abbreviations for metric linear measurements are:

mm = millimeter one-thousandth of a meter

cm = centimeter one-hundredth of a meter

km = kilometer one thousand meters

Specifications on drawings, blueprints, and sketches are commonly expressed in terms of hundredths, thousandths, and ten-thousandths for extremely accurate work. Steel rules, micrometers, indicators, and many other precision measurement instruments are based on the metric system.



Dimensioned Drawing

SESSION X DECIMAL NUMBER

SESSION OBJECTIVES:

At the conclusion of this session, participants will:

understand and be able to read decimal numbers,

be able to add and subtract decimal numbers,

be able to multiply and divide decimal numbers.

TIME	CONTENT	PROCESS/ ACTIVITY	MATERIALS
10 Min.	Review and Overview	Guided Discussion	Metric System Handout
15 Min.	Decimal Numbers	Lecturette Individual Activity	Handouts #1 & #2
25 Min.	Adding & Subtracting	Lecturette Individual Activity	Handout #3 & #4
10 Min.	Major Learning Points	Recap Major Learning Points Individual Activity	Handout

SESSION X DECIMAL NUMBERS

REVIEW AND OVERVIEW

Review with participants the handout, "Metric System," from the previous session.

Write on the blackboard or flip-chart the agenda for today's lesson:

Decimal Numbers

Adding and Subtracting Decimals

DECIMAL NUMBERS

Pass out the Handout, "Decimal Numbers." Review the handout with the participants. Have the participants answer the two questions on the handout. Randomly ask participants for the answers to the two questions.

Pass out the Handout, "Reading Decimals." Review the information from the handout to the participants. Call on participants to read the decimal numbers on page 2.

ADDING AND SUBTRACTING DECIMALS

Pass out the Handout - "Rules for Adding and Subtracting Decimals." Using the blackboard, review the rules for adding decimals, taking the participants through the 4 steps on the handout.

Review the rules for subtracting decimals, taking the participants through the 4 steps on the handout.

After reviewing the rules for adding and subtracting decimals, pass out to participants the "Practice Exercise" on Adding and Subtracting Decimals.

Give participants and about 8 to 10 minutes to do the exercise individually. Then give them 5 minutes to work in groups of two or three to compare and work out the answers.

Call on groups to respond to the different problems in the exercise.

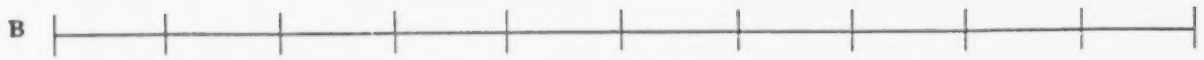
MAJOR LEARNING POINTS

Pass out the "Review Exercise" Handout to participants. Give them about 10 minutes to complete the exercise.

Call on individuals to provide the answers to the questions on the exercise. Ask them to identify the steps they followed in coming up with their answers.

SESSION X

DECIMAL NUMBERS



The line above represents one centimeter on a metric ruler.

The decimal system is a system of numbers based on ten.

Notice that the line above is divided into tenths. These parts, such as 1/10 or 3/10, are often referred to as decimal fractions.

How many tenth are represented on the line?

How many tenth make a **whole**?

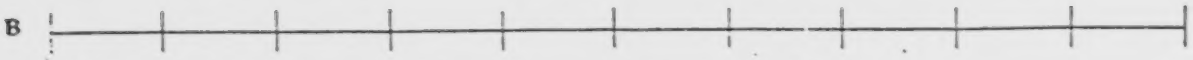
The part of 1/10 is also written .1 or .10 and is read one-tenth (.1) or ten hundredths (.10). This form of a factions is known as a **decimal**. The decimal form of a fraction is easier to use than the common fraction.

The period in the .1 and the (.) is called the decimal point. The decimal fraction differs from a common fractions in that it is written on one line as a whole number with a period in front of it. You have been using decimals for some time in working with problems of dollars and cents. $5.25 could also be read, "five and twenty-five hundredths dollars." $4.10 could also be read, "four and one-tenth," or "four and ten-hundredths" dollars.

Any whole number with a decimal point in front of it is a decimal fraction.

SESSION X

DECIMAL NUMBERS



The line above represents one centimeter on a metric ruler.

The decimal system is a system of numbers based on ten.

Notice that the line above is divided into tenths. These parts, such as 1/10 or 3/10, are often referred to as decimal fractions.

How many tenth are represented on the line? 10

How many tenth make a **whole**? 10

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Any whole number with a decimal point in front of it is a decimal fraction.

READING DECIMALS

We say "and" in reading the period (decimal point) between dollars and cents: $5.25 as "five dollars **and** twenty-five cents." So also the decimal point is all decimals is read "and." Thus, 5.25 is read "five **and** twenty-five hundredths."

Since decimals are a system of counting by **tens**, you will notice the table below that each succeeding decimal place in **one-tenth** of the preceding decimal place name. The following chart show the place names and positions.

To read these numbers, ignore the decimal point and the adjacent zeros. Say the number, then say the place name of the last digit to the right.

2765
972
857
+ 1724
6318

TABLE OF DIGITS

					Millions
					Hundred-Thousands
					Ten-Thousands
6	1			2	Thousands
3	7	8	9	7	Hundreds
1	2	5	7	6	Tens
8	4	7	2	5	Units

Notice that the number of decimal places to the right of the decimal point agrees with the number of zeros in 10, 100, 1000, etc. Thus, one place is

tenths, (one zero is 10), 2 places is hundredths (two zeros in 100), and so on through as many decimal places as there may be.

Example:

.63 is read sixty-three **hundredths**

.136 is read one hundred thirty-six **thousandths**

.5625 is read five thousand six hundred twenty-five **ten thousandths**

3.5 is read three and five **tenths**

2.136 is read two and one hundred thirty-six **thousandths**

Read the decimal numbers, using **and** for the decimal point.

152.8 152.08 152.008

152.0008 1520.008

Hint: The signal that a number has a decimal part is the word "and." The number 6.03 is read "six and three hundredths."

Avoid using "and" in saying or writing a number.

RULES FOR ADDING DECIMALS

Write decimal points under each other

Fill in zeros

Add each column

Locate decimal point - place in column it appears with each number

SESSION I

RULES FOR ADDING AND SUBTRACTING DECIMALS

Adding Decimals

In the machine shop, drafting lab, and many other industrial settings, computation of dimensions from drawings and sketches often require the addition of two or more decimals. The typical example is determining the distance between two points when each point is presented in decimal form. The addition of theses decimals is the same as addition of regular whole numbers except the location of the decimal point demands additional considerations.

RULES FOR ADDING DECIMALS

Write numbers so that the decimal points are under each other

Fill in zeros so that all numbers have the same number of decimal places

Add each column the same as for regular addition of whole numbers

Locate the decimal point in the answer by placing it in the same column in which it appears with each number

SESSION I

RULES FOR SUBTRACTIONS OF DECIMALS

Write numbers so decimal points are under each other

Fill in zeros

Subtract each column

Place decimal point in the answer in same column it appears with each number

Example: Add .865 + 1.3 + 375.006 + 71.1357 + 735

Step 1: Write the number so that the decimal points are under each other in a vertical line

```
  .865
 1.3
375.006
 71.1357
+735.
```

Step 2: Fill in zeros so that all numbers have the same number of decimal places.

```
  .8650
 1.3000
375.0060
 71.1357
+735.0000
```

Step 3: Add each column the same as for regular addition of whole numbers

```
  .8650
 1.3000
375.0060
 71.1357
+735.0000
1183 3067
```

Step 4: Locate the decimal point in the answer by placing it in the same column in which it appears with each number

.8650
1.3000
375.0060
71.1357
+735.0000
1183.3067

SESSION IX

RULES FOR SUBTRACTING DECIMALS

The subtraction of one decimal dimension from another is a common and necessary practice for completion in most industrial jobs. The process is the same as subtraction of whole numbers with the exception of providing for an accurate placement of the decimal point.

RULES FOR SUBTRACTIONSOF DECIMALS

Write numbers so that the decimal points are under each other

Fill in zeros so that all numbers have the same number of decimal places

Subtract each column the same as for regular subtraction of whole numbers

Locate the decimal point in the answer by placing it in the same column in which it appears with each number

Example: Determine the difference of the following dimensions:
62.1251 sq. in. and 24.102 sq. in.

Step 1: Write the number so that the decimal points are under each other in a vertical line

62.1251
24.102

Step 2: Fill in zeros so that all numbers have the same number of decimal places.

62.1251
24.1020

Step 3: Subtract each column the same as for regular addition of whole numbers

62.1251
-24.1020
38 0321

Step 4: Locate the decimal point in the answer by placing it in the same column in which it appears with each number

62.1251
-24.1020
38.0231

SESSION IX

1.5

ADDING AND SUBTRACTING DECIMALS
PRACTICE EXERCISE

1. $\begin{array}{r} .6 \\ 1.3 \\ +2.8 \\ \hline \end{array}$

2. $\begin{array}{r} 72.8 \\ 164.02 \\ +174.01 \\ \hline \end{array}$

3. $\begin{array}{r} 185.7 \\ 83.02 \\ + \ 9.013 \\ \hline \end{array}$

4. $\begin{array}{r} 0.9306 \\ 0.0850 \\ 335.06 \\ + \ 2.0875 \\ \hline \end{array}$

5. 3.45 + 65.987 + 34.789

6. 23.45 + .329 + 102.4

7. $\begin{array}{r} 2.0666 \\ -1.3981 \\ \hline \end{array}$

8. $\begin{array}{r} 18.16 \\ -9.104 \\ \hline \end{array}$

9. $\begin{array}{r} 1.002 \\ - \ .9428 \\ \hline \end{array}$

10. $\begin{array}{r} 1.22 \\ -1.01 \\ \hline \end{array}$

11. $\begin{array}{r} 0.6 \\ -.124 \\ \hline \end{array}$

12. $\begin{array}{r} 18.4 \\ -18.1 \\ \hline \end{array}$

13. $\begin{array}{r} 1347.008 \\ -108.134 \\ \hline \end{array}$

14. 111.010 - 12.163

15. 64.7 - 24

16. At the start of a trip we took, the speedometer read 417.9 miles, and at the end of the trip the speedometer read 842.3 miles. How far had we traveled?

17. A machinist found a shaft to be 2.15 inches across. She put it on a lathe and cut it down to 1.92 inches. How much did she cut?

18. The specifications given is .3125 with a + or - .005. What is the largest a measurement could be?
the smallest?

SESSION XI DECIMAL NUMBER

SESSION OBJECTIVES:

At the conclusion of this lesson, participants will be able to:

multiply and divide decimals,

round off decimals.

TIME	CONTENT	PROCESS/ ACTIVITY	MATERIALS
10 Min.	Review and Overview	Lecturette Guided Discussion	Practice Exercise
15 Min.	Multiplying Decimals	Lecturette Individual & Group Activity	Handouts #1 & #2
15 Min.	Dividing Decimals	Lecturette Individual & Group Activity	Handout #3 & #4
15 Min.	Rounding Decimals	Lecturette Individual & Group Activity	Handouts #5 & #6
5 Min.	Major Learning Points	Recap Major Learning Points	

SESSION XI DECIMAL NUMBERS

REVIEW AND OVERVIEW

For review purposes, use the Practice Exercise that was used at the last session. As you call on participants to provide the answers to each question, ask them to identify the steps they followed in coming up with their answers.

Objectives for this lesson including providing training in

a- Multiplying and Dividing Decimals
b- Rounding Off Decimal Numbers

MULTIPLYING DECIMALS

Pass out the Handouts - "Multiplying Whole Numbers" (H#1), "Rules for Multiplying and Dividing Decimals," (H#2) .

Review with participants the rules for multiplying whole numbers, and then rules for multiplying decimals. Take them through the four steps.

DIVIDING DECIMALS

Pass out the Handouts - "Rules for Dividing Decimals" (H#3). Review with participants the rules for dividing decimals. Take them through the different steps with the examples provided.

Pass out the Practical Exercise on "Multiplying and Dividing of Decimals" (H#4). Give the participants 10 to 15 minutes to do the exercise individually. Then give them 5 to 8 minutes to work in groups of two to compare and work out the answers.

Call on groups to respond to the different problems in the exercise.

ROUNDING DECIMALS

Distribute the handout entitled "Rounding Off Decimals (H#5).

Explain and demonstrate rounding off decimals on the black-board or flip-chart. Go through the example with the participants. Answer any questions they have about rounding off decimals.

Practice:
Distribute the handout entitled "Rounding Numbers Exercise". Go through the exercise with participants. Answer questions they have about round off decimals. Allow about 6 to 8 minutes for participants to complete the exercise.

Check the exercise with participants. Be sure they understand the process.

MAJOR LEARNING POINTS

Recap major learning points by reviewing with participants the steps in "Multiplying and Dividing Decimals" and "Rounding Decimals."

In arithmetic multiplication is indicated by a "times" sign (x). To work multiplication problems such as 3 x 4, 5 x 12, 4 x 4, or 126 x 26, you must know the multiplication (or times) table. This table is shown below.

	1	2	3	4	5	6	7	8	9	10	11	12
1	1	2	3	4	5	6	7	8	9	10	11	12
2	2	4	6	8	10	12	14	16	18	20	22	24
3	3	6	9	12	15	18	21	24	27	30	33	36
4	4	8	12	16	20	24	28	32	36	40	44	48
5	5	10	15	20	25	30	35	40	45	50	55	60
6	6	12	18	24	30	36	42	48	54	60	66	72
7	7	14	21	28	35	42	49	56	63	70	77	84
8	8	16	24	32	40	48	56	64	72	80	88	96
9	9	18	27	36	45	54	63	72	81	90	99	108
10	10	20	30	40	50	60	70	80	90	100	110	120
11	11	22	33	44	55	66	77	88	99	110	121	132
12	12	24	36	48	60	72	84	93	108	120	132	144

Multiplication Table

To read this table find the number on the left and the number across the top which are to be multiplied. The point on the table at which the numbers meet in the columns is the multiplied answer.

Example:

5 x 5 = 25

Find the 5 on the left and the 5 across the top. Note that the two 5's intersect at 25.

When working a multiplication problem you cannot count on having a "times table" available. For this reason, the multiplication table should be learned

RULES OF MULTIPLICATION

Any number multiplied by 0 is 0. For example, 7 x 0 = 0, 64 x 0 = 0, 31 x 0 = 0, and 103 x 0 = 0. Any number multiplied by 1 is equal to the number multiplied. For example, 1 x 1 = 1, 7 x 1 = 7, 4 x 1 = 4, and 106 x 1 = 106.

RULES FOR MULTIPLYING AND DIVIDING DECIMALS

MULTIPLYING DECIMALS

Multiplying decimals is a convenient and somewhat simplified way of adding them. Instead of taking one number and listing it, then adding it to itself a certain number of times, it is easier and there is less chance for error if the two numbers are multiplied.

With the exception of locating or pointing off the decimal places in the answer, the entire multiplication process is identical with that used for whole numbers.

RULES FOR MULTIPLYING DECIMALS

Multiply the same as with whole numbers. Ignore the decimal point until multiplication is complete.

Count the number of decimal places to the right of the decimal point in both numbers being multiplied.

Place the decimal point in the answer by starting at the extreme right number and counting as many places to the left as there are in the total number of decimal places found in both numbers being multiplied.

Check your work. Multiply the whole number parts of the problem. This estimate shows about what the answer should be.

Example: Multiply 38.693 x 2.08

Step 1: Multiply the same as with whole numbers. Ignore the decimal point until multiplication is complete.

```
  38.693
 x 2.08
 309544
 77386
 8048144
```

Step 2: Count the number of decimal places to the right of the decimal point in both numbers being multiplied.

```
  38.693 - 3 decimal places
 x 2.08 - 2 decimal places
 309544
 77386
 8048144 - 5 decimal places
```

Step 3: Place the decimal point in the answer by starting at the extreme right number and counting as many places to the left as there are in the total number of decimal places found in both numbers being multiplied.

```
  38.693 - 3 decimal places
 x 2.08 - 2 decimal places
 309544
 77386
 80.48144 - 5 decimal places
```

Step 4: Check your work. Multiply the whole number parts of the problem. This estimate shows about what the answer should be.

```
 38
 x2
 76
```

76 is very close to the whole number part of the answer, 80. This estimate shows that the answer could not be 8.036912 or 803.6912

DIVISON OF DECIMALS

Dividing Decimals

Division is a process for determining how many times one number is contained in another. The division of decimals, like all other mathematical processes for decimals, is essentially the same as for whole numbers except that provisions must be made for the location of the decimal in the answer.

REMEMBER:

dividend - number to be divided
divisor - number by which it is divided
remainder - number, smaller than the divisor, when the final step is subtracted

RULES FOR DIVIDING DECIMALS

Place the number to be divided (called the dividend) inside the division box.

Place the divisor outside and the dividend under the division sign.

Move the decimal point in the divisor to the extreme right. A caret (*) may be used to show the location of the new decimal points. The divisor then becomes a whole number.

Move the decimal point the same number of places to the right in the dividend.

NOTE: Zeros are added in the dividend if it has fewer numbers than the divisor.

Mark the position of the decimal point in the quotient directly above the decimal point in the dividend.

Divide as whole numbers and place each figure in the quotient directly above the number in the dividend.

Add zeros after the decimal point in the dividend if it cannot be divided by the divisor.

Continue the division until the quotient has as many places as are required for the answer.

Example 1: 25.5 - 12.75

Step 1: Place the number to be divided (called the dividend) inside the division box.

12.75 - divisor
25.5 - dividend

Step 2: Place the divisor outside and the dividend under the division sign.

12.75/ 25.5

Step 3: Move the decimal point in the divisor to the extreme right. The divisor then becomes a whole number.

12.75*/ 25.5

Step 4: Move the decimal point the same number of places to the right in the dividend.

NOTE: Zeros are added in the dividend if it has fewer numbers than the divisor.

$$12.75^{*} \overline{)\ 25.50^{*}}$$

2 places 2 places

Step 5: Mark the position of the decimal point in the quotient directly above the new decimal point in the dividend.

$$\underline{\quad .\quad} \overline{)\ 12.75^{*} / 25.50^{*}}$$

Step 6: Divide as whole numbers and place each figure in the quotient directly above the number in the dividend.

Add zeros after the decimal point in the dividend if it cannot be divided by the divisor.

Continue the division until the quotient has as many places as are required for the answer.

$$\underline{\quad 2. \quad} \overline{)\ 12.75^{*} / 25.50^{*}}$$

Example 2: 123.573 - 137.4

Step 1: Place the number to be divided (called the dividend) inside the division box.

137.4 - divisor
123.573 - dividend

Step 2: Place the divisor outside and the dividend under the division sign.

137.4 / 123.573

Step 3: Move the decimal point in the divisor to the extreme right. The divisor then becomes a whole number.

137.4* / 123.573

Step 4: Move the decimal point the same number of places to the right in the dividend.

NOTE: Zeros are added in the dividend if it has fewer numbers than the divisor.

137.4* / 123.5*73
1 place 1 place

Step 5: Mark the position of the decimal point in the quotient directly above the new decimal point in the dividend.

```
      .
137.4* / 123.5*73
```

Step 6: Divide as whole numbers and place each figure in the quotient directly above the number in the dividend.

Add zeros after the decimal point in the dividend if it cannot be divided by the divisor.

Continue the division until the quotient has as many places as are required for the answer.

```
      .8993
137.4* / 123.5*73
    1099 2
    1365 3
    1236 6
     128 70
     123 66
       5 040
       4 122
         918
```

SESSION XI

MULTIPLYING & DIVIDING of DECIMALS
PRACTICE EXERCISE

1. 3.018 x 6.203 = 18.720654

2. 21.3 x 1.2 = 25.56

3. 1.6 x 1.6 = 2.56

4. 83.061 x 2.423 = 201.256803

5. 1.643 x 1.21 = 1.98803

6. 44.02 x 6.01 = 264.5602

7. 63.12 x 1.12 = 70.6944

8. 183.1 x .234= 42.8454

9. 68.142 x 23.62= 1609.51404

Take each answer to at least 4 decimal places

10. 2.6) 861.83 = 331.4731

11. 1.4) 42.6 = 30.4286

12. .8) 4.63 = 5.7875

13. 11.3) 113.113 = 10.01

14. 1.2) 620.6 = 517.1667

15. 6)6.6682 = 1.1137

16. 18.4) 100.184 = 5.4448

17. 67.1) 446.467 = 6.6538

18. 1.1) 104 = 94.5455

19. Since water weighs about 8.855 pounds to the gallon, how much does 9.4 gallons weigh?
= 83.237

20. Frank took the car to the gas station to be filled with gas. It took 15.4 gallons to fill the tank. The gas was 58.9 cents (.589) a gallon. How much did it cost?
= $ 9.07

Answer the following:

1. Specifications given on a print are 67.5 +/- .50. What is the largest the measurement could be? 67.55

   the smallest?
   = 67.45

Round off the following numbers to the nearest tenth.

1. 1.279 = 1.3
2. 45.361 = 45.4
3. .981 = 1.0
4. 12.645 = 12.6
5. .609 = .6

Using the chart below answer the following questions:

1. How far is it from New Orleans to New York? = 1360

2. How far is it from Chicago to Los Angeles? = 2115

AUTOMOBILE MILEAGE	Chicago, Ill.	Denver, Colo.	Houston, Tex.	Los Angeles, Calif.	Miami, Fla.	New York, N.Y.	San Francisco, Calif.
Atlanta, Ga.	671	1436	852	2245	663	868	2579
Boston, Mass.	992	2016	1865	3004	1615	220	3265
Chicago, Ill.	[illegible]	1062	1139	2115	1352	824	2240
Cleveland, Ohio	311	1393	1372	2393	1327	493	2571
Dallas, Tex.	923	820	241	1476	1367	1580	1790
Denver, Colo.	1062	[illegible]	1061	1148	2104	1794	1324
Detroit, Mich.	271	1333	1306	2415	1437	670	2511
Houston, Tex.	1139	1061	[illegible]	1585	1256	1714	1950
Las Vegas, Nev.	1905	843	1426	305	2572	2637	624
Los Angeles, Calif.	2115	1148	1585	[illegible]	2841	2784	411
Memphis, Tenn.	579	1054	560	1816	1050	1114	2214
Miami, Fla.	1352	2104	1256	2841	[illegible]	1395	3192
Montreal, Quebec	804	1866	1839	2948	1749	381	3044
New Orleans, La.	981	1326	360	1945	896	1360	2296
New York, N.Y.	824	1794	1714	2784	1395	[illegible]	3045
Philadelphia, Pa.	766	1770	1624	2726	1278	90	3021
Portland, Oreg.	2255	1329	2295	1098	3433	2992	687
St. Louis, Mo.	283	848	856	1832	1346	1057	2168
Seattle, Wash.	2076	1411	2377	1280	3421	2852	869
Toronto, Ontario	469	1531	1504	2613	1631	513	2709
Washington, D.C.	701	1696	1476	2680	1130	238	2968

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ROUNDING OFF DECIMALS

The degree of precision to which a hole is to be drilled or measurement taken sometimes determines how accurately the answer to a problem is computed. Many detailed drawings indicate accuracy in terms of thousandths or ten-thousandths of an inch. However, in determining dimensions, the answers may be accurate to four, five, or more decimal places.

Sometimes numbers must be rounded off to be displayed on a chart.

The process of expressing decimal numbers at a predetermined degree of precision is called "rounding-off decimals." To round-off a decimal is to write it with fewer decimal places. We round numbers when we do not need to be exact.

RULES FOR ROUNDING-OFF DECIMALS

Determine the desired degree of accuracy - how many places the decimal is to be rounded

Add 1 to the number of places needed.

Circle the numbers that many places to the right of the decimal, just drop the extra numbers.

If the number you circle is less than 5 increase the number ahead of it by 1, leave the number as it is if the number is less than 5

Example: Round-off the decimal .549752 to three places

Step 1: Determine the desired degree of accuracy - how many places the decimal is to be rounded

3 places

Step 2: Add 1 to the number of places needed.

3 places + 1 place = 4

Step 3: Circle the numbers that many places to the right of the decimal, just drop the extra numbers.

.549752

Step 4: If the number you circle is less than 5 increase the number ahead of it by 1, leave the number as it is if the number is less than 5

7 is greater than 5

.549 + .001 = .550

ROUNDING NUMBERS
EXERCISE

Round the following decimal numbers to three decimal places:

1. 2236.1005
2. 2987.1015
3. .92765
4. .56251
5. 2.15625
5. 1183.3067
6. 38.1051
7. .93006
8. 80.36912
9. .8993
10. .00587
11. 1609.51404
12. .0796
13. 1.98803
14. 201.256803
15. 3318.08606

16. Is 32.77 closer to 32.5 or 33?
17. Is 33.36 closer to 33 or 33.5?
18. Is 3.529 closer to 3.52 or 3.53?
19. Is 43.39 closer to 43 or 44?
20. Is 2.574 closer to 2.570 or 2.580?

SESSION XII MATHEMATICS FOR SPC

SESSION OBJECTIVES:

At the conclusion of this session, participants will:

have reviewed adding and subtracting fractions

TIME	CONTENT	PROCESS/ ACTIVITY	MATERIALS
10 Min.	Review and Overview	Lecturette	"Rounding Numbers" Exercise
20 Min.	Review of Fractions	Lecturette Individual Activity	Handouts #1 & #2
20 Min.	Adding and Subtraction of Fractions	Demonstration Individual Activity	Handout #3 & #4
10 Min.	Major Learning Points	Recap Major Learning Points	

SESSION XII MATHEMATICS FOR SPC

REVIEW & OVERVIEW

Review the previous lesson by referring to the exercise on "Rounding Numbers." Ask participants what problems they had with the exercise. Clarify any questions they have on the process for rounding numbers.

This session deals with FRACTIONS: Adding, Subtracting, Multiplying, and Dividing Fractions.

REVIEW OF FRACTIONS

Distribute the handout entitled, "Fractions". Explain the different types of fractions and how fractions are reduced to their lowest terms. Review the handout, step by step.

Distribute the handout, "Fractions: Exercise". Allow about 5 to 8 minutes for participants to complete the exercise. Check at least one of each section with participants.

ADDITION AND SUBTRACTION OF FRACTIONS

Distribute the handout entitled "Rules for Adding and Subtracting Fractions".

Demonstrate addition of fractions on the board or flip-chart. Go through the example with the participants. Answer any questions they have about addition of fractions.

Demonstrate the rules for subtraction of fractions on the board or flip-chart.

Distribute the practice exercise entitled "Addition and Subtraction of Fractions". Go through the example with the participants. Answer questions they may have about subtraction of fractions. Allow 5 to 8 minutes for participants to complete the exercise.

Check the exercise with participants. Be sure they understand the process. Have them to complete the rest of the problems before the next class meeting.

MAJOR LEARNING POINTS

Recap Major Learning Points by having the participants refer to the two exercises used in this lesson. Ask it they had any special problems with them. Review the steps to be followed in adding and subtracting fractions.

Kinds of Fractions

Proper fractions - the numerator is always smaller than the denominator.

Examples: 5/8, 3/16, 3/4, 1/4, 11/16 and 15/16

Improper fractions - have a numerator which is greater than or equal to the denominator.

Examples: 8/2, 3/2, 10/4, 11/8, and 15/16

Mixed fractions - have a whole number and a fraction.

Examples: 1 1/2, 10 3/4, 5 11/16, and 2 3/8

FRACTIONS

The use of fractions is very common in industry since they are needed to express a part of a whole number. The inch markings on a rule or steel tape represent whole numbers. The other lines indicate fractional parts of an inch.

Parts of Fractions

The two numbers in a fraction are:

numerator **tells how many parts you have**

denominator **tells how many parts in the whole**

For example, in 9/16 the numerator "9" indicates that 9 parts of 16 will be used if the inch were divided into 16 parts.

Reduction of Fraction to Lowest Terms.

This process is used to reduce proper fractions and fractional parts of a mixed number to its lowest terms. A fraction which has been reduced to its lowest forms is one whose numerator and denominator cannot be divided evenly by the same whole number.

When you start working problems with fractions you will need to be able to reduce fractions to their lowest terms. the lowest common denominator.

To Reduce a Fraction to its Lowest Terms use one of the following methods: (**Note:** the number must divide evenly into both the numerator and the denominator.)

1) Divide the numerator and denominator by the numerator.

Example: $\frac{8}{16} = \frac{8 \div 8}{16 \div 8} = \frac{1}{2}$

2) Divide the numerator and denominator by the smaller number that will divide into both evenly.

Example: $\frac{8}{10} = \frac{8 \div 2}{10 \div 2} = \frac{4}{5}$

To Find the Lowest Common Denominator

If the largest denominator in an addition or subtraction problem doesn't work use one of the following methods:

Example: 1/5 + 1/4 =

Step 1: Multiply denominators

5 X 4 = 20

Step 2: Raise each fraction to the 20th.

1/5 = 4/20

+ 1/4 = 5/20

Step 3: Add as usual

1/5 = 4/20

+ 1/4 = 5/20

9/20

2) Go through the multiplication table to determine the smallest common denominator.

Example: 1/3 + 1/6 + 1/4 =

Go through the multiplication table of the largest denominator to find the number all the denominators will divide into evenly

1 X 6 = 6, 3 and 4 won't both divide into evenly

2 X 6 = 12, yes

3 X 4 = 12

4 X 3 = 12

so 4/12 + 2/12 + 3/12 = 9/12

Reducing Numbers

If a mixed number, such as 6 12/16, is to reduced, only the fractional part of the mixed number, 12/16, is reduced.

Example:

$$\frac{12}{16} = \frac{3x4}{4x4} = \frac{3}{4} \text{ X } 1 = \frac{3}{4}$$

Converting Mixed Number to Fractions

When working with mixed numbers it often becomes necessary to convert a mixed number to a fraction. This operation is accomplished by multiplying the whole number by the denominator of the fraction and the numerator is added to the product. The result is written over the fraction bar with the original denominator beneath.

To convert 5 3/4 to an improper fraction:

Step 1: multiply the whole number (5) by the denominator (4).

5x4=20

Step 2: add the numerator (3) to your answer (20).

3+20=23

Step 3: write your answer (23) over the denominator (4)

23/4

Thus, 5 3/4 = 23/4

The answer is an improper fraction, but it is sometimes important to change mixed numbers to fractions before a problem can be solved.

Changing Improper Fractions to Mixed Numbers

Step 1: Divide the numerator by the denominator

9/8 + 8/9 = 1 r1

Step 2: Place your remainder over the denominator

9/8 + 8/9 = 1 r1 = 1 1/9

SESSION XII

FRACTIONS: EXERCISE

Reduce the following fractions to their lowest terms:

1. 2/4 = $\frac{1}{2}$
2. 8/16 = $\frac{1}{2}$
3. 2 4/16
   $2\frac{1}{4}$
4. 18/16
   $1\frac{2}{16} = 1\frac{1}{8}$
5. 15/10
   $1\frac{5}{10} = 1\frac{1}{2}$
6. 5 9/4
   $7\frac{1}{4}$

Convert these mixed numbers to fractions:

7. 1 1/2
   $1\frac{1}{2} = \frac{3}{2}$
8. 3 11/16
   $3\frac{11}{16} = \frac{59}{16}$
9. 10 3/4
   $10\frac{3}{4} = \frac{43}{4}$
10. 5 2/5
    $5\frac{2}{5} = \frac{27}{5}$
11. 4 9/10
    $4\frac{9}{10} = \frac{49}{10}$
12. 8 5/8
    $8\frac{5}{8} = \frac{69}{8}$

Change the following improper fractions to mixed numbers:

13. 5/3
    $1\frac{2}{3}$
14. 17/4
    $4\frac{1}{4}$
15. 42/8
    $5\frac{3}{8} = 5\frac{1}{4}$
16. 21/16
    $1\frac{5}{16}$
17. 51/10
    $5\frac{1}{10}$
18. 7/2
    $3\frac{1}{2}$

RULES FOR ADDING AND SUBTRACTING FRACTIONS

ADDITION OF FRACTIONS WITH DIFFERENT DENOMINATORS

First rewrite the fractions with its least common denominator.

Then add the numeratorsand simplify the answer, by reducing the answer to the lowest possible terms.

Example: Add 1/4 and 8/16

Step 1: First rewrite the fractions with its least common denominator.

$$\begin{array}{r} \frac{1}{4} = \frac{4}{16} \\ +\frac{8}{16} = \frac{8}{16} \\ \hline \end{array}$$

Step 2: Then add the numeratorsand simplify the answer, by reducing the answer to the lowest possible terms.

$$\begin{array}{r} \frac{1}{4} = \frac{4}{16} \\ +\frac{8}{16} = \frac{8}{16} \\ \hline \frac{12}{16} = \frac{3}{4} \end{array}$$

SUBTRACTIONS OF FRACTIONS

First rewrite the fractions with its least common denominator.

Then subtract the numerators and simplify the answer, by reducing it to the lowest possible terms.

Example: subtract 2 3 4 - 2/5

Step 1: First rewrite the fractions with its least common denominator.

2 3/4 = 2 15/20
\- 2/5 = 8/20

Step 2: Then subtract the numerators and simplify the answer, by reducing it to the lowest possible terms.

2 3/4 = 2 15/20
\- 2/5 = 8/20
7/20

If mixed numbers, subtract the whole numbers.

2 3/4 = 2 15/20
\- 2/5 = 8/20
2 7/20

ADDITION AND SUBTRACTIONS OF FRACTIONS

Add the following:

1. 1/8 + 5/8 = $\frac{6}{8} = \frac{3}{4}$

2. 3/8 + 3/4 = $\frac{9}{8} = 1\frac{1}{8}$

3. 3/10 + 1/5 = $\frac{5}{10} = \frac{1}{2}$

4. 3/16 + 9/32 = $\frac{15}{32}$

5. 1/10 + 3/4 = $\frac{17}{20}$

6. 11/16 + 3/8 + 9/32 = $\frac{43}{32} = 1\frac{11}{32}$

7. 1 3/4 + 5/8 + 1/2 = $1\frac{15}{8} = 2\frac{7}{8}$

Subtract the following:

8. 7/8 - 1/4 = $\frac{5}{8}$

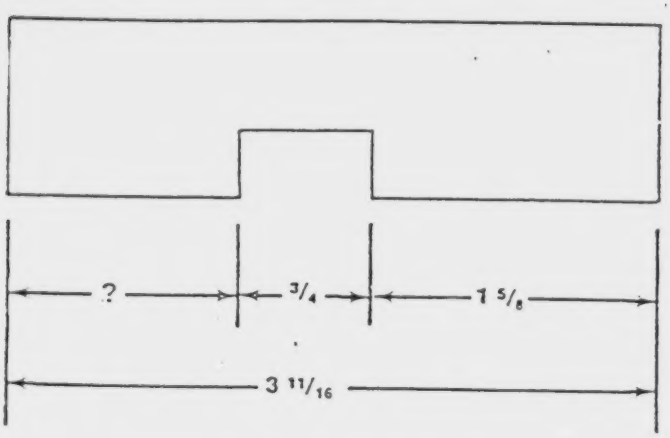
9. 3/4 - 3/8 = $\frac{3}{8}$

10. 4 1/4 - 2 3/4 = $1\frac{2}{4} = 1\frac{1}{2}$

11. 12 - 6 5/8 = $5\frac{3}{8}$

12. 2 3/10 - 3/4 = $1\frac{11}{20}$

13. The piece shown below measures a total of 3 11/16" and you know that on side is 1 5/8" and the opening is 3/4". How long is the other side?



1 5/16

14. A 3/4" diameter hole must be drilled 1/16" larger to accommodate a 3/4" diameter bolt. What size drill will be required?

13/16"

15. Sam had a pipe measuring 32 2/3" long. He cut off 3/4" so that the pipe would fit into a space. How long was the pipe after being cut?

31 11/12"

SESSION XIII MATHEMATICS FOR SPC (2)

SESSION OBJECTIVES:

At the conclusion of this lesson, participants will:

have reviewed multiplying and dividing fractions, and practiced converting fractions to decimals.

TIME	CONTENT	PROCESS/ ACTIVITY	MATERIALS
5 Min.	Review and Overview	Questions & Answers	
15 Min.	Multiplication of Fractions	Demonstration Individual Activity	Handouts #1 & #2
15 Min.	Division of Fractions	Demonstration Individual Activity	Handout #3 & #4
15 Min.	Converting Fractions to Decimals	Lecturette Demonstration Individual Activity	Handouts #5 & #6
10 Min.	Major Learning Points	Recap Major Learning Points	

MULTIPLICATION OF FRACTIONS

Explain that multiplication of fractions is like multiplying whole numbers. You don't have to worry about finding common denominators.

Distribute the handout, "Rules for Multiplication of Fractions" (Handout #1)

Practice
Demonstrate multiplication of fractions on the board or flip-chart. Distribute the practice exercise, "Multiplication of Fractions" (Handout #2). Go through the example with the participants. Answer any questions they have about division of fractions. Allow about 6 to 8 minutes for participants to complete the exercise.

DIVISION OF FRACTIONS

Distribute the handout "Rules for Division of Fractions" (Handout #3). Demonstrate division of fractions on the board or flip-chart.

Distribute the practice exercise "Division of Fractions" (Handout #4). Go over the example with the participants. Answer questions they have about the division of fractions. Allow about 6 to 8 minutes for participants to complete the exercise.

Check at least one multiplication and one division problem with participants. Be certain they understand the process. Have them to finish the rest of the problems prior to the next class.

CONVERTING FRACTIONS TO DECIMALS

Ask participants when they see or use fractions on their jobs. Taking measurements from a ruler is an example. If they respond that they do not see or use fractions on the job, suggest that they look for various times when they see fractions in the plant.

Distribute the handout, "Rules for Converting Fractions to Decimals". Explain that because some measurements are taken in fractions form, the SPC chart may have dimensions given as a decimal number. This means they must be able to convert fractions to decimals.

Practice

Demonstrate the conversion of fractions to decimals on a flip-chart or board. Distribute the practice exercise entitled "Decimals and Common Fractions" (Handout #5). Go through the example with the participants. Answer questions they have about the conversion of fractions to decimals. Allow about 6 to 8 minutes for participants to do the exercise.

Check the first 10 problems of the exercise with participants. Be sure they understand the process. Assign the rest of the problems for the next class.

MAJOR LEARNING POINTS

Recap Major Learning Points by asking students to tell you one of the things they learned in this lesson. Give each participant an opportunity by asking each one to tell you one thing, then add any additional points.

Major Learning Points

Decimals readings from some tools may be more precise than they actually need for documentation, so they may have to round off decimals.

In measuring certified dimensions to be plotted on control charts, dimensions are sometimes taken with instruments which give measurement in fraction forms.

They have reviewed the principles of adding, subtracting, multiplying and dividing fractions.

They have practiced the conversion of fractions to decimals.

They have had an opportunity to practice these mathematical calculations, which they might need as they begin documenting for SPC.

RULES FOR THE MULTIPLICATION OF FRACTIONS

Change all mixed numbers to improper fractions

Cancel (divide numerator and denominator by the same number, it possible)

Multiply the numerators

Multiply the denominators

Simplify the answer

Example: 1 1/2 x 3/4 x 12 =

Step 1: Change all mixed numbers to improper fractions

3/2 x 3/4 x 12/1 =

Step 2: Cancel (divide numerator and denominator by the same number, it possible)

$$\overset{3}{3/2} \times 3/4 \times \underset{1}{12/1} =$$

Step 3: Multiply the numerators

$$\overset{3}{3/2} \times 3/4 \times \underset{1}{12/1} = 27/$$

Step 4: Multiply the denominators

$$3/2 \times 3/4 \times \frac{12}{1} = \frac{27}{2}$$

Step 5: Simplify the answer

$$3/2 \times 3/4 \times \frac{12}{1} = \frac{27}{2} = 13\ 1/2$$

MULTIPLICATION OF FRACTIONS

Multiply the following:

1. 1/2 X 1/4 = $\frac{1}{8}$

2. 3/4 X 2/5 = $\frac{3}{10}$

3. 5/16 X 3/10 = $\frac{3}{32}$

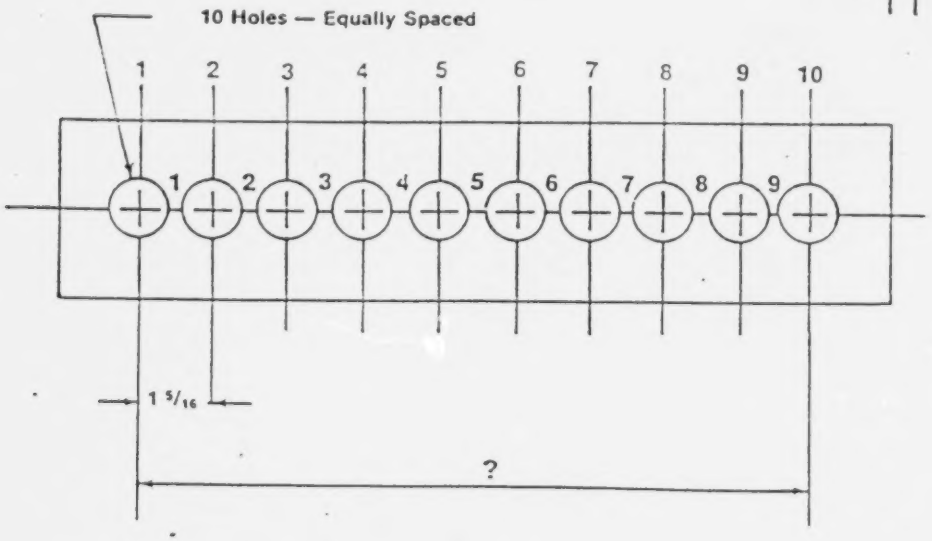
4. 7/8 X 3 1/2 = $\frac{49}{16} = 3\frac{1}{16}$

5. 2 5/8 X 1 2/16 = $\frac{189}{64} = 2\frac{61}{64}$

6. 3/10 X 15/16 X 4/5 = $\frac{9}{40}$

7. Note in the drawing below there are 9 spaces separating the holes. There is 1 5/16" from the center of the holes. How wide is the piece shown?

$11\frac{13}{16}$"



8. In the piece you are working on three are slots, each measures 1/4". What is the total size of the three slots?

$\frac{3}{4}$"

MULTIPLICATION OF FRACTIONS

Multiply the following:

1. 1/2 X 1/4 =

2. 3/4 X 2/5 =

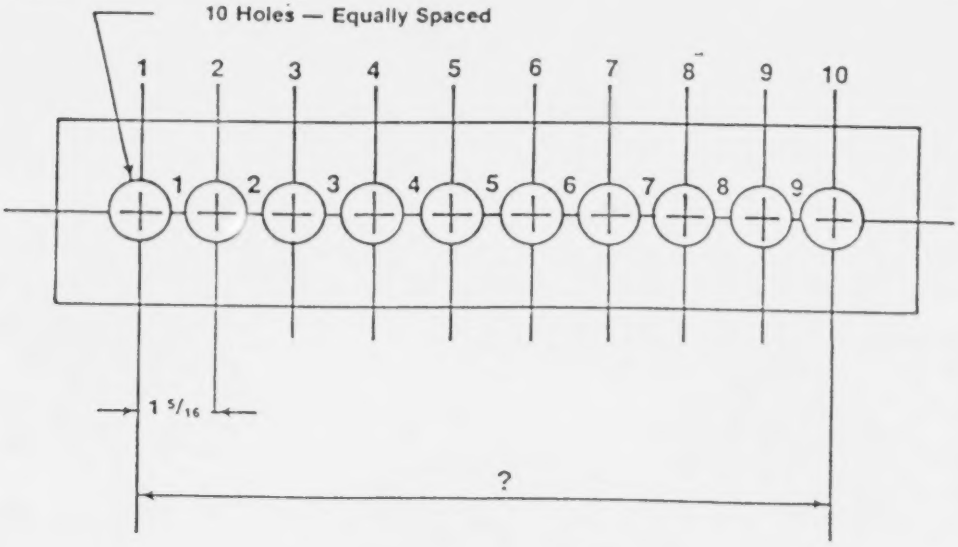
3. 5/16 X 3/10 =

4. 7/8 X 3 1/2 =

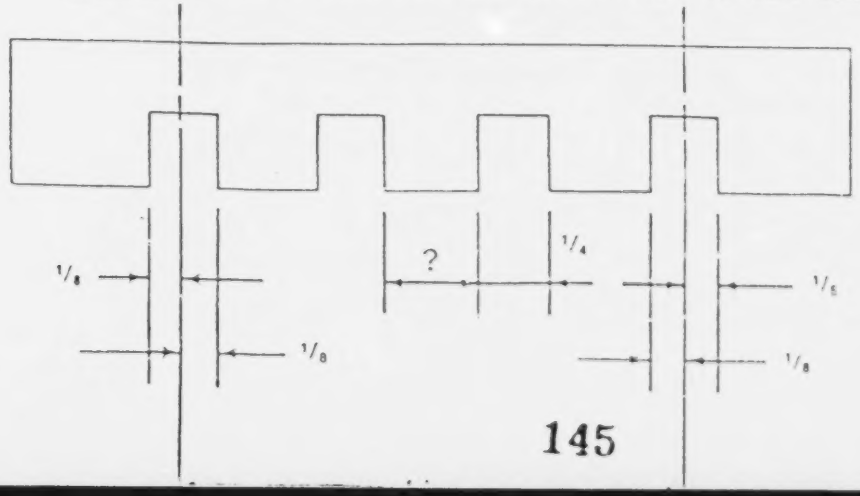
5. 2 5/8 X 1 2/16 =

6. 3/10 X 15/16 X 4/5 =

7. Note in the drawing below there are 9 spaces separating the holes. There is 1 5/16" from the center of the holes. How wide is the piece shown?



8. In the drawing below there are three slots shown, each measures 1/4". What is the total size of the three slots?



RULES FOR THE DIVISION OF FRACTIONS

Change all mixed numbers to improper fractions

Invert the divisor and multiply

Cancel (divide numerator and denominator by the same number, it possible)

Multiply numerators and denominators

Simplify the answer

Example: 1 7/8 - 5/12 =

Step 1: Change all mixed numbers to improper fractions

15/8 - 5/12 =

Step 2: Invert the divisor

15/8 - 12/5 =

Step 3: Cancel (divide numerator and denominator by the same number, it possible)

$$\frac{\overset{3}{\cancel{15}}}{\underset{2}{\cancel{8}}} - \frac{\overset{3}{\cancel{12}}}{\underset{1}{\cancel{5}}} =$$

Step 4: Multiply numerators and denominators

$$1\frac{3}{8} - 1\frac{3}{8} = 9/2$$
$$2 \quad 1$$

Step 5: Simplify the answer

$$1\frac{3}{8} - 1\frac{3}{8} = 9/2 = 4\ 1/2$$
$$2 \quad 1$$

DIVISION OF FRACTIONS

Divide the following:

1. 1/2 ÷ 1/4 = 2

2. 3/5 ÷ 1/2 = $\frac{6}{5}$ = $1\frac{1}{5}$

3. 3/10 ÷ 7/8 = $\frac{12}{35}$

4. 3/8 ÷ 1 5/16 = $\frac{2}{7}$

5. 3 1/4 ÷ 2 9/16 = $\frac{52}{41}$ = $1\frac{11}{41}$

6. If the total width of a piece is 11 13/16" and it divided into sections that measure 1 5/16" from center to center. How many sections make up the piece?

9

Decimals and Common Fractions

We have seen that decimals are really fractions, and that we use them instead of common fractions. Every common fraction can be changed to a decimal.

Below we see just how common and decimal fractions are equivalent:

one tenth = $\frac{1}{10}$ = .1
five tenths = $\frac{5}{10}$ = .5
one and six tenths = $1\frac{6}{10}$ = 1.6
six and fifteen hundredths = $6\frac{15}{100}$ = 6.15
eighteen and twenty-five thousandths = $18\frac{25}{1000}$ = 18.025

one hundredth = $\frac{1}{100}$ = .01
twelve hundredths = $\frac{12}{100}$ = .12
one thousandth = $\frac{1}{1000}$ = .001
fifteen thousandths = $\frac{15}{1000}$ = .015

1. After each word number (in Column A) write its fractional form (or mixed numbers) in Column B; write its decimal form in Column C:

COLUMN A	COLUMN B	COLUMN C
a. three tenths	.3	3/10
b. fifteen hundredths	.15	15/100
c. five thousandths	.005	5/1000
d. twenty-seven thousandths	.027	27/1000
e. four and six tenths	4.6	4 6/10
f. fifteen and seven tenths	15.7	15 7/10
g. thirty and three hundredths	30.03	30 3/100
h. one hundred twenty and two thousandths	120.002	120 2/1000
i. fifteen and fifteen ten-thousandths	15.0015	15 5/10,000
j. six and five millionths	6.000005	6 5/1,000,000
k. five hundred and five tenths	500.5	500 5/10
l. five hundred and five hundredths	500.05	500 5/100

2. Change each fraction to the designated new fraction and then to the decimal equivalent:

$\frac{1}{5} = \frac{2}{10} = .2$ $\quad \frac{3}{5} = \frac{6}{10} = .6$ $\quad \frac{4}{5} = \frac{8}{10} = .8$ $\quad \frac{1}{2} = \frac{5}{10} = .5$

$\frac{1}{4} = \frac{25}{100} = .25$ $\quad \frac{3}{4} = \frac{75}{100} = .75$ $\quad \frac{17}{50} = \frac{34}{100} = .34$ $\quad \frac{1}{25} = \frac{4}{100} = .04$

$\frac{4}{25} = \frac{16}{100} = .16$ $\quad \frac{7}{20} = \frac{35}{100} = .35$ $\quad \frac{9}{25} = \frac{36}{100} = .36$ $\quad \frac{1}{8} = \frac{125}{1000} = .125$

3. Before each number in Column B and Column C, write the letter of the word-number in Column A which matches:

COLUMN A	COLUMN B	COLUMN C
a. one fifth	c - 100	.01 - e
b. seven tenths	d - $\frac{1}{1000}$	5.005 - f
c. one hundred	f - $5\frac{5}{1000}$	100.1 - g
d. one thousandth	a - $\frac{1}{5}$	.001 - d
e. one hundredth	g - $100\frac{1}{10}$	.7 - b
f. five and five thousandths	b - $\frac{7}{10}$	.2 - a
g. one hundred and one tenth	e - $\frac{1}{100}$	100 - c

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XIII

CONVERTING FRACTIONS TO DECIMALS

Sometimes it is useful to use fraction names for numbers. Other times decimal names for number are more useful. As we have seen decimals are really fractions that we use them instead of common fractions. Every common fractions can be changed to a decimal. It is an important skill to be able to change from one form to the other so that you are working with the most useful form. This might happen when you take a measurement with a ruler or tape and get a measurement like 1 3/8" and yet to chart it for quality, you need to change it to a decimal number.

Decimals are a special way of writing those fractions that have denominators of 10, 100, 1,000 and so on. Instead of writing 2/10 we write 0.2. Below are some common and fractional equivalents:

one tenth = 1/10 = .1
five tenths = 5/10 - .5
one and six tenths = 1 6/10 = 1.6
one hundredth = 1/100 - .01
twelve hundredths = 12/100 = .12
one thousandth = 1/1000 = .001
fifteen thousandths = 15/1000 = .015
eighteen and twenty-five thousandths = 18 25/1000 = 18.025

RULES FOR CONVERTING FRACTIONS TO DECIMALS

Set up the denominator as the dividend and the numerator as the divisor

Place a caret beside the denominator to indicate where the decimal will be

Place the decimal directly above the caret. Add zeros to get the needed number of places plus one

Divide to get the decimal number

Write the remainder as a fraction

Round off the desire number of places

Example: convert 3/7 to a decimal

Step 1: Set up the denominator as the dividend and the numerator as the divisor

$$\overline{7/\,3}$$

Step 2: Place a caret beside the denominator to indicate where the decimal will be

$$\overline{7/\,3^{*}}$$

Step 3: Place the decimal directly above the caret. Add zeros, if needed to get the needed number of places plus one

$$\overline{7/\,3^{*}0000}$$

Step 4: Divide to get the decimal number

```
  .4285
7/ 3*0000
  28
   20
   14
   60
   56
    40
    35
     5
```

Step 5: Write the remainder as a fraction

```
  .4285
7/ 3*0000 = .4285 5/7
  28
   20
   14
   60
   56
    40
    35
     5
```

Step 6: Round off the desire number of places

.4285 5/7 = .4286 = .429 = .43

. . . . . .

SPECIAL NOTE TO INSTRUCTORS

AT THE CONCLUSION OF SESSION XIII -- "MATHEMATICS FOR SPC (2)" -- INFORM THE CLASS THAT YOU ARE GOING TO COVER "VISUAL INSPECTIONS" FOR THE NEXT SESSION (SESSION XIV).

ASK THAT EACH PARTICIPANT BRING TO CLASS A PART AND A SAMPLE PART THAT CAN BE USED FOR COMPARISON PURPOSES DURING THAT CLASS (SESSION XIV).

ALSO, IN PREPARATION FOR SESSION XV, ARRANGE TO HAVE SEVERAL OF THE FOLLOWING: A MICROMETER, A CALIPER, AND A MEASURING RULER. THESE WILL BE NEEDED FOR DEMONSTRATION PURPOSES IN [illegible] CLASS (SESSION [illegible]

. . . . . .

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SESSION XIV INSPECTIONING FOR SPC

SESSION OBJECTIVES:

At the conclusion of this Session, participants will:

- work through part of the problem solving process, and
- practice using the cause and effect diagram as a problem solving technique.

TIME	CONTENT	PROCESS/ ACTIVITY	MATERIALS
10 Min.	Review	Individual Activity	Handout #1
5 Min.	Session Overview	Lecturette	Objectives
10 Min.	Random Sampling	Individual Activity Brainstorming	Handout #2
10 Min.	Visual Inspections	Individual Activity Buzz Groups	Handouts #3 & and #4
20 Min.	Demonstration of Visual Visual Inspections	Demonstrations Participant Directed	Sample Piece & Piece Produced
5 Min.	Major Learning Points	Recap Major Learning Points	

SESSION XIV INSPECTIONING FOR SPC

REVIEW

Distribute the handout, "Fraction Review". Allow participants about 5 minutes to partially complete the review. Instruct them to do line 1 of the additions, line 3 of the subtractions, line 5 of the multiplication, and line 8 of the division. If they have time, they can then work on the other lines.

Check the answers and respond to any questions them may have about fractions. Explain, or have one of the participants to explain.

Ask participants to list other things they learned from the previous session, which should include:

In measuring certified dimension to be plotted on charts, dimensions are sometimes taken with instruments which give measurements in fraction form.

They have reviewed the principles of adding, subtracting, multiplying, and dividing fractions.

They have practiced the conversion of fractions to decimals.

They have had an opportunity to practice these mathematical calculations, which they will be needing as they begin documenting for SPC.

OVERVIEW

Write on the board (or flip-chart) the objectives for this session:

Discuss and list the benefits of random sampling.

Conduct a visual inspection of a part with an approved sample.

RANDOM SAMPLING

Remind participants that they have been reviewing fractions and decimals because of the way dimensions may be given and used for SPC documentation.

Explain that when they begin charting for SPC they will not check every feature of every part, but will only check specified characteristic "samples".

Distribute the Handout, "Random Sampling". Allow participants about 5 minutes to read the handout and underline or circle the main ideas. The main ideas they should highlight include:

examination of small portions can determine the overall quality of an entire work,

random sampling is done because 100% inspection is expensive and sometimes destructive to the product.

Remind participants that for SPC documentation they will likely be inspecting 25 samples per production run or 8 hour shift.

BRAINSTORMING

Have participants brainstorm by listing as many benefits of random sampling as they can. These should include:

- reduction of scrap and rework
- reduction of variation
- providing a smoother operation
- insuring good processes and better use of manpower and processes
- prevention of defects and allowing troubleshooting

VISUAL INSPECTION

Distribute the Handout, "How Good An Inspector Are You?". Allow participants about 5 minutes to complete the exercise.

Debrief the activity by reminding participants that the purpose of the exercise is to reinforce the idea that 100% inspection is not 100% effective.

BUZZ GROUP

Distribute the handout, "Visual Quality Control". Divide the class into groups of two or three. They are to:

read the information provided
answer the questions

Allow about 5 minutes for this exercise. Debrief the handout with the participants.

DEMONSTRATION OF VISUAL INSPECTION

Begin by explaining that visual inspections are something that many of them are doing already, so you want them to help you inspect the part you have with the approved sample. Use a first run sample; have participants talk you through a demonstration of a visual inspection.

Ask participants what are the characteristics they can usually look for in a visual inspection. This list must include:

size
shape
color
number of holes or openings
texture/feel (not visual, but can be done without instruments)
thickness - to a degree, especially for more experienced workers.

Explain that the more a person does visual inspections the better they become. Many workers can tell as much by looking or feeling a part as they can by using various measuring devices.

After the group has covered all the points they can on the comparison of the sample with the part, have them to determine the acceptability of the part.

PRACTICE

Distribute the handout, "Visual Inspection Check List". Have participants divide into pairs. They are to have the person they are paired with to do a visual inspection of the parts they brought based on the sample part. As their partner is inspecting, they are to complete the inspection check list, to evaluate how well the inspector does.

After the first person has completed the visual inspection, the other person is to do a visual inspection of the part the other person brought.

Allow about 10 minutes for the pairs to inspect each other's pieces. At the end of the time period, ask participants for comments on the practice and how well their partner did. Have participants review the features they looked for on the parts they inspected.

RECAP MAJOR LEARNING POINTS

Instruct participants to draw up a check list of what to look for and the steps to follow to conducting a visual inspection.

Have them turn in the lists to use as a review at the next session.

MAJOR LEARNING POINTS:

Inspections are important to the process of quality improvement; through inspections problems are identified and actions taken to make corrections.

100% inspections are not always possible nor practical. Therefore, random sampling is used.

Random sampling, when done as instructed by Quality, can be effective as 100% inspections.

FRACTION REVIEW

Add. Simplify.

1. $8\frac{1}{3} + \frac{2}{9} = 14\frac{5}{9}$; $6 + 3\frac{4}{15} = 9\frac{4}{15}$; $\frac{3}{6} + \frac{3}{5} = 1\frac{1}{10}$; $1\frac{1}{3} + \frac{5}{12} = 5\frac{9}{12} = 5\frac{3}{4}$; $3\frac{2}{3} + 2\frac{1}{2} = 5\frac{7}{6} = 6\frac{1}{6}$

2. $12\frac{3}{8} + 7 = 19\frac{3}{8}$; $\frac{3}{5} + \frac{4}{5} = 1\frac{2}{5}$; $4\frac{5}{6} + \frac{4}{5} = 4\frac{49}{30} = 5\frac{19}{30}$; $3\frac{4}{15} + 8\frac{3}{5} = 11\frac{13}{15}$; $2\frac{4}{9} + 4\frac{2}{9} = 6\frac{6}{9} = 6\frac{2}{3}$

Subtract. Simplify.

3. $\frac{3}{4} - \frac{7}{10} = \frac{1}{20}$; $9 - \frac{7}{11} = 8\frac{4}{11}$; $16 - \frac{5}{9} = 15\frac{4}{9}$; $\frac{5}{6} - \frac{3}{4} = \frac{1}{12}$; $\frac{8}{8} - \frac{7}{8} = \frac{1}{8}$

4. $42\frac{1}{6} - 27\frac{3}{5} = 14\frac{17}{30}$; $19\frac{1}{8} - 14\frac{2}{3} = 4\frac{11}{24}$; $7\frac{7}{12} - \frac{9}{24} = 7\frac{5}{24}$; $25\frac{2}{5} - \frac{1}{2} = 24\frac{9}{10}$; $14\frac{2}{3} - 12\frac{1}{6} = 2\frac{6}{6} = 2\frac{1}{2}$

Muitiply. Simplify.

5. $\frac{1}{8} \times \frac{3}{5} = \frac{3}{40}$; $\frac{3}{4} \times \frac{16}{30} = \frac{4}{10} = \frac{2}{5}$; $9 \times \frac{2}{3} = 6$

6. $\frac{1}{5} \times 5\frac{1}{10} = \frac{51}{50} = 1\frac{1}{50}$; $6\frac{1}{2} \times 4\frac{2}{3} = \frac{91}{3} = 30\frac{1}{3}$; $4\frac{1}{4} \times 1\frac{1}{9} = \frac{85}{18} = 4\frac{13}{18}$

7. $\frac{1}{2} \times 10 = 5$; $\frac{4}{5} \times 2\frac{1}{5} = \frac{44}{25} = 1\frac{19}{25}$; $6\frac{3}{4} \times 4 = 27$

Divide. Simplify.

8. $\frac{3}{4} \div \frac{9}{16} = \frac{4}{3} = 1\frac{1}{3}$; $8 \div \frac{3}{8} = \frac{64}{3} = 21\frac{1}{3}$; $\frac{9}{10} \div 2\frac{2}{5} = \frac{3}{8}$

9. $9\frac{1}{3} \div 3 = \frac{28}{9} = 3\frac{1}{9}$; $4\frac{5}{7} \div 3\frac{2}{3} = \frac{9}{7} = 1\frac{2}{7}$; $7\frac{3}{5} \div 2\frac{1}{4} = \frac{152}{45} = 3\frac{17}{45}$

10. $\frac{1}{2} \div \frac{1}{2} = 1$; $12 \div \frac{3}{4} = 16$; $\frac{1}{2} \div 2 = \frac{1}{4}$; $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

RANDOM SAMPLING

Random sampling is examining only small portions of large batches of products. The overall quality of the entire batch, as well as the capabilities of the machines to produce quality products can be determined by random sampling. For example, Homelite produces an average of 15 mowers per hour, only about 4 are inspected. The general level of quality is controlled without examining every mower produced.

Sampling plays an important role in statistical process control because of the following:

1. One hundred percent inspection of all parts is expensive.
2. Testing sometimes results in destruction of the product.
3. Small sample testing, when done properly, allows us the same confidence that 100 percent inspection would yield for a much lower cost.

While some parts do require 100 percent inspection, testing small samples is very common in most high volume production processes. For example, as a

batch of plastic is being processed, it is sampled and tested. From this sample, the manufacturer is able to determine whether or not something out of the ordinarily has occurred to alter the consistency of the product. Only a very small portion of the plastic is subjected to testing since it fairly accurately represents the condition of the whole batch. So, small sample random sampling allows workers to tell when standards are being met.

HOW GOOD AN INSPECTOR ARE YOU?

100% inspection is not always 100% effective. To show the effectiveness of 100% inspection read through the following paragraph and count the number of x's. Only read the paragraph once and count the x's

You Arx A Kxy Pxrson

"Xvxn through my typxwritxr is an old modxl, it works vxry wxll--xxcxpt for onx kxy. You would not think that with all thx othxr kxys functioning propxrly, onx kxy not working would hardly bx noticxd; but just onx kxy out of whack sxxms to ruin thx wholx xffort.

"You may say to yoursxlf--Wxll, I'm only onx pxrson. No onx will noticx if I don't do my bxst. But it doxs makx a diffxrxncx bxcausx to bx xffxctivx an organization nxxds activx participation by xvxry onx to thx bxst of his or hxr ability.

"So thx nxxt time you think you arx not important, rxmxmbxr my old typxwritxr. You arx a kxy pxrson." (Original Source: Pasadena Weekly Journal of Business)

Total number of x's: _____

HOW GOOD AN INSPECTOR ARE YOU?

100% inspection is not always 100% effective. To show the effectiveness of 100% inspection read through the following paragraph and count the number of x's. Only read the paragraph once and count the x's

You Arx A Kxy Pxrson

"Xvxn through my typxwritxr is an old modxl, it works vxry wxll--xxcxpt for onx kxy. You would not think that with all thx othxr kxys functioning propxrly, onx kxy not working would hardly bx noticxd; but just onx kxy out of whack sxxms to ruin thx wholx xffort.

"You may say to yoursxlf--Wxll, I'm only onx pxrson. No onx will noticx if I don't do my bxst. But it doxs makx a diffxrxncx bxcausx to bx xffxctivx an organization nxxds activx participation by xvxry onx to thx bxst of his or hxr ability.

"So thx nxxt time you think you arx not important, rxmxmbxr my old typxwritxr. You arx a kxy pxrson." (Original Source: Pasadena Weekly Journal of Business)

Total number of x's: 69

VISUAL QUALITY CONTROL

Visual inspections are necessary to find certain types of defects. A defective product is not acceptable to our customers. Visual inspection allow us to catch defective parts which might not otherwise be caught. After identifying problems, then we must determine what is causing the problem so that if corrective actions are needed, they can be taken.

WHAT IS MEANT BY A VISUAL INSPECTION?

WHAT DO YOU LOOK FOR WHEN YOU ARE DOING A VISUAL INSPECTION?

WHAT DEFECTS MIGHT A VISUAL INSPECTION REVEAL THAT WOULD NOT BE NOTICED BY OTHER FORMS OF INSPECTIONS?

VISUAL QUALITY CONTROL

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WHAT IS MEANT BY A VISUAL INSPECTION?

looking at a piece to find possible defects - inspection by sight

WHAT DO YOU LOOK FOR WHEN YOU ARE DOING A VISUAL INSPECTION?

color
scratch marks
number of openings
approximate location of openings, etc.

WHAT DEFECTS MIGHT A VISUAL INSPECTION REVEAL THAT WOULD NOT BE NOTICED BY OTHER FORMS OF INSPECTIONS?

color - shades
machine marks
scratches on finish

VISUAL INSPECTION
CHECK LIST

Rank your partner according to how well you feel they did the following during their inspection:

	Ranking				
Identified:	Poor	Fair	Good	Excellent	N/A
1. Significant markings					
2. Similarities with sample piece					
3. Difference from sample piece					
Checked:					
4. Size					
5. Color					
6. Number of holes or openings					
7. Smoothness of finish					
8. Shape					
9. Significant markings					

SESSION XV PROBLEM SOLVING FOR QUALITY

SESSION OBJECTIVES:

Upon completion of this session, participants will:

Be able to conduct inspections using some of the commonly used measuring instruments,

Be able to work through part of the problem solving process.

TIME	CONTENT	PROCESS/ ACTIVITY	MATERIALS
5 Min.	Review	Guided Discussion	Check List From Last Session
5 Min.	Session Overview	Lecturette	Objectives
15 Min.	Measuring Devices	Lecturette Group Demonstration	Measuring Devices
10 Min.	Problem Solving	Lecturette	Handout #1
20 Min.	Using the cause and effect Diagram for Developing Alternatives	Group Activity	Handout #2
5 Min.	Recap Major Learning Points	Group Activity	

SESSION XV PROBLEM SOLVING FOR QUALITY

REVIEW

Utilize the lists the participants prepared at the end of the last session for "Major Learning Points". These lists were for (1) what to look for and the steps to follow in conducting a visual inspection, and (2) identifying some of the major tools used in measuring dimensions and providing a step-by-step outline of how an inspection is conducted.

The Major Learning Points were:

Inspections are important to the process of quality improvement; through inspections problems are identified and actions taken to make corrections.

100% inspections are not always possible nor practical. Therefore, random sampling is used.

Random sampling, when done as instructed by Quality, can be as effective as 100% inspections.

Visual inspections are one form of inspections. A visual inspection might reveal some defects that might not be revealed otherwise.

Measuring devices are used for the inspection of some attributes.

It is important to know when and how to use the tools needed for inspection of the parts you produce.

OVERVIEW

Materials to be covered in this session include:

using some of the more commonly used measuring instruments to conduct inspections,

working through part of the problem solving process.

MEASURING DEVICES

Explain that not all inspections will be visual. Some characteristics will be variable that require precise measurements to be checked and recorded. In order to perform these there are some measuring devices with which they should be familiar, including:

Rulers
micrometer
caliper

Demonstration/Practice
Have participants demonstrate the use of a measuring instrument. Let each participant practice with each of the instruments available.

PROBLEM SOLVING

Distribute the handout, "Problem Solving for Quality". Briefly explain the six steps of the problem solving process.

* Identify the problem
  (Describe the problem as specifically as possible)

* Analyze the problem
  (Describe what is happening now)

* Generate potential solutions
  (Come up with as many possible solutions as you can, at this point don't eliminate any possibility)

* Select the best alternative
  (Evaluate the consequences and determine what you feel is the best solution to the problem)

* Develop an action plan for implementing the solution, by determining
  - what actions need to be taken
  - order they should be taken
  - who will you need to get approval from
  - how you will approach them with your solutions to convince them that it is the best alternative
  - who else is involved
  - how the plan will affect them
  - how you will let them know about your plan

  All of this will need supervisory approval.

Divide the class into two groups. Allow about 10 minutes for the groups to complete the first two steps in the problem solving process.

CAUSE AND EFFECT DIAGRAM

Distribute the practice exercise, "Fishbone Diagram". Explain that it is used to identify possible problems in a process. Major possible causes are written in on the spines of the fishbone, and their related causes branch out from the spines. Many process problems originate from one of the following sources:

Men
Machines
Methods
Materials
Environment . . . may be a factor at times.

Answer questions they have about the cause and effect diagram.

Divide the class back into problem solving groups. They are to use the fishbone diagram to continue their problem solving practice. The fishbone diagram should be used to generate alternatives. Once alternatives have been identified, they can take each possible solution, determine the consequences, and select their best solution.

Allow about 15 minutes for the groups to complete the exercise. They should complete the third and fourth steps of the problems solving process.

RECAP MAJOR LEARNING POINTS

Debrief the problem solving process by having each group to select a spokes-person to give the class a summary of what they have done.

Remind the participants that they will continue the problem solving exercise at the next session. They are to turn in whatever written materials they have completed. These will be turned back to them at the next session.

PROBLEM SOLVING

1. IDENTIFY THE PROBLEM

A. Describe the problem as specifically as possible.

B. What is the root cause?

Where and when does the problem first occur?

2. ANALYZE THE PROBLEM

A. Describe what is happening now.

B. What do you want to see happen?

C. Who or what is effected by this problem?

How are they effected by this problem?

3. GENERATE POTENTIAL SOLUTIONS

What are things that could be done to improve the process. List as many as possible.

4. CONSIDER THE CONSEQUENCES

List each potential solution then identify the possible negative consequences and advantages of each.

POTENTIAL SOLUTIONS	ADVANTAGES	NEGATIVE CONSEQUENCES	RATING

5. SELECT THE BEST ALTERNATIVE

Use the rating space on the previous page rate each possible solution.

Describe your best overall solution.

6. DEVELOP AN ACTION PLAN FOR IMPLEMENTATION

A. List all the things you will need to do in order to put your plan into operation.

Number them in the order in which each step needs to be taken.

B. Who or what will be affected by your plan?

How will they be affected?

What is the best way to let others affected by your plan know about the plan?

C. How will you know whether your plan is working well or not?

PART IMPORTANCE

PART PRODUCED:

FINISHED PRODUCT IT GOES INTO:

IMPORTANCE TO THE FINISHED PRODUCT.

WHAT HAPPENS IF YOUR PART DOESN'T FUNCTION/FIT PROPERLY?

FISHBONE DIAGRAM

No two things are ever exactly alike, ASSIGNABLECAUSES are those thing affecting a process that we can do something about.

A cause and effect or fishbone diagram is a problem solving techniques which can be used to brainstorm for assignable causes in a process. Once identified then corrections can be made to bring the process back in control.

STEPS

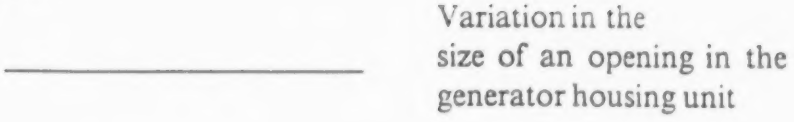
1. Name the problem.

   Example:

   Variation in the size of an opening in the generator housing unit

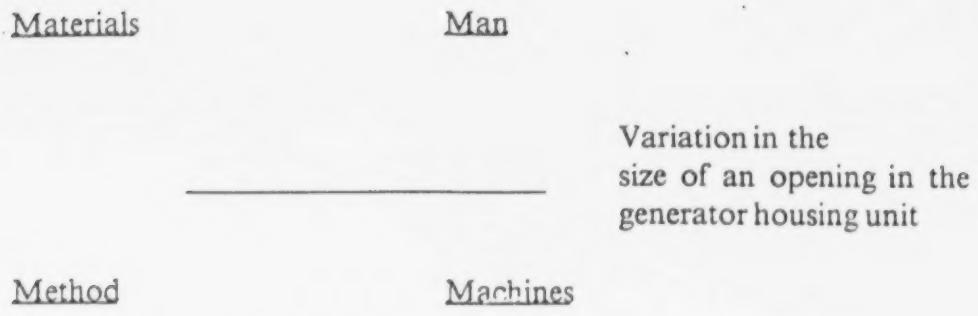
2. Add the spine

   Example:



3. Add the areas of main causes of problems, which make up the bones.

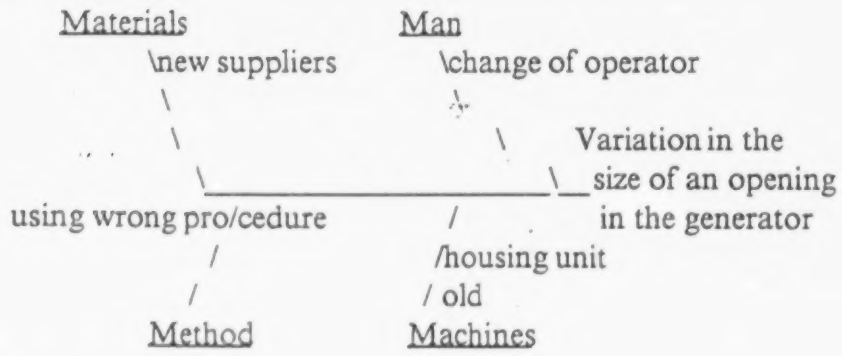
Example:



Environment could be a 5th bone!

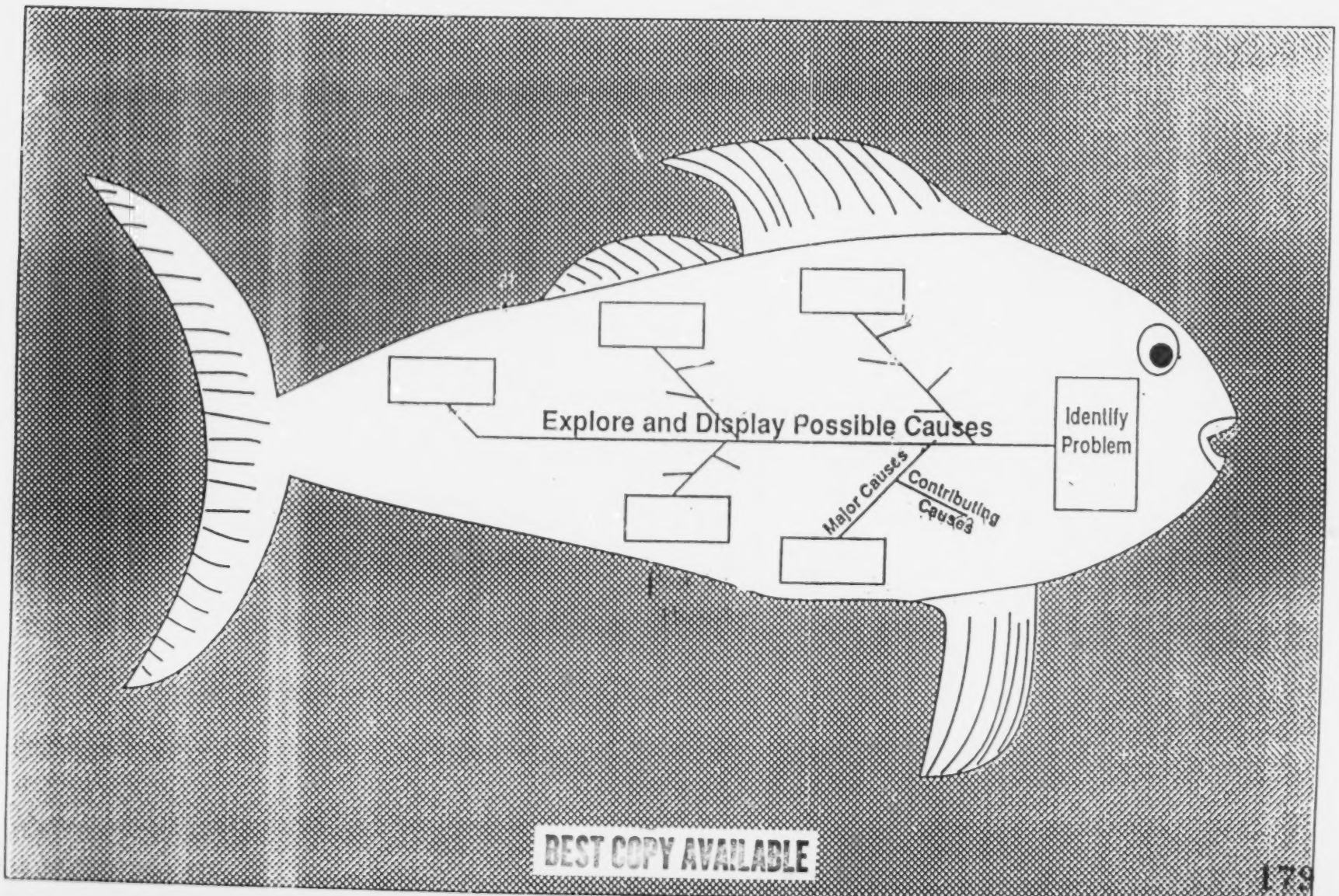
4. Add meat to the bones by filling with possible causes associated with the main reasons.

Example:



Environment could be a 5th bone!

CAUSE AND EFFECT DIAGRAM



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SESSION XVI PROBLEM SOLVING FOR QUALITY (2)

SESSION OBJECTIVES:

At the conclusion of this session, participants will:

* practice using the cause and effect diagram as a problem solving technique,
* Recognize the importance of positive communication,
* Practice listening.

TIME	CONTENT	PROCESS/ ACTIVITY	MATERIALS
10 Min.	REVIEW	GUIDED DISCUSSION	LISTS FROM PREVIOUS SESSION
5 Min.	SESSION OVERVIEW	LECTURETTE	OBJECTIVES
10 Min.	PLANNING FOR PROBLEM SOLVING	LECTURETTE	PROBLEM SOLVING FOR QUALITY
10 Min.	SUMMARIZING	GUIDED DISCUSSION	
15 Min.	PLANNING FOR PROBLEM SOLVING	GROUP ACTIVITY	
10 Min.	DEBRIEF PROBLEM SOLVING	GROUP REPORTS	

SESSION XVI PROBLEM SOLVING FOR QUALITY (2)

REVIEW

Review with participants the handouts from the previous session. These were:

"Problem solving for Quality"

"Fishbone Diagram"

The materials they had utilized in developing their own problem solving plan from the previous session

PLANNING FOR PROBLEM SOLVING

Use this time to make certain that the participants are at steps three and four of the problem solving process. The participants should be back in their problem solving groups.

SUMMARIZING

Ask someone to tell you about the most interesting or entertraining television show they have seen since the previous session. After a participant has done this, ask how someone takes a 30 minute, or hour, or longer show and condenses it to less than 5 minutes, or the time the participant took to tell about the program.

You should be told such things as:
only the main ideas/actions are described
only tell about the main characters
eliminate descriptions of scenes that were not essential to getting the main point across

Ask how someone decided what is the main idea or point. With guidance they should come up with the concept of taking everything that happened and making that decision; based on what most of the time was spent on, or what happened at the beginning that was also included in some way at the end, or what the main character of the show was involved in, etc.

Get participants to relate this to the job. How do they summarize what's happening to a supervisor? They should tell you:

* things out of the ordinary - supervisor know what generally goes on
* people affected and how they are affected
* effects on the manufacturing process or product
* main points you want to get across

Explain that the same way they would summarize what's happening to a supervisor is the same they would develop an action plan for implementing possible solutions. Just as they might make suggestions by talking with their supervisor the action plan is simply a summary of actions to share. Emphasize to them that a summary is nothing more than a clear, concise, description of what they are wanting to describe.

Explain that summaries have to sometimes be written rather than done orally. In that case, you basically write down what you would say. Because once something is written down and it may be going to someone who may not know us, we have to be careful to be as clear as possible. They may or may not be able to get with us to ask questions.

PLANNING FOR PROBLEM SOLVING

Group Activity

Have the problem solving groups to get back together to complete the final step of the problem solving process. Allow groups about 10 minutes to complete their plan.

* step-by-step how solutions will be implemented
* who will be involved
* whose approval will be needed
* who will be affected by changes
* how they will be affected
* things people will need to know before changes occur
* how to let them know about the changes
* who will be responsible
* how they will know whether the plan is working or not

RECAP MAJOR LEARNING POINTS

Debrief the entire problem solving process by having each group select a spokesperson to give the class a summary of what they have done.

SESSION XVII COMMUNICATING FOR QUALITY

SESSION OBJECTIVES:

At the conclusion of this session, participants will:

* be able to summarize their work on the problem solving process.

TIME	CONTENT	PROCESS/ ACTIVITY	MATERIALS
10 Min.	Review	Questions & Answers	Objectives of Previous Lesson
5 Min.	Overview	Lecture	Session Objectives
25 Min.	Communicating for Quality Improvement	Guided Discussion	Cartoon
10 Min.	Listening	Individual Activity & Lecturette	Blank Paper
10 Min.	Major Learning Points	Individual Activity	Blank Paper

SESSION XVII COMMUNICATING FOR QUALITY

REVIEW

Use the objectives from the previous session. Have participants briefly describe what they did with each objective in the previous session, which would include:

* The problem solving process involves the major steps of
  - identifying the problem
  - analyzing the problem
  - generating potential solutions
  - considering the possible negative and positive effects of each alternative
  - selecting the "best" solution
  - developing an action plan to implement the solution

* Whatever is done in part of the plant affects others throughout the assembly process

* To aid in problem solving, the fishbone or cause and effect diagram can be used which helps to show potential problems which can then be used to help identify the problem and generate solutions

* An action plan should be developed before trying to implement changes.

OVERVIEW

Session objectives are for participants to:

* Recognize the importance of positive communication skills

* Practice using listening skills

COMMUNICATING FOR QUALITY IMPROVEMENT

Explain that when they have reached this point (develop the action plan) in the problem solving process, they will have to communicate with others; and how they communicate is often as important as what they communicate.

Ask participants how they like to be talked to, regardless of where they are or who is talking with them.

(continued on next page)

You will probably hear thing like -- they "want people to..."

* be courteous
* talk to the them like they know what they're doing
* be positive
* show respect
* talk to calmly
* explain things to them
* look at them
* take their feelings into consideration
* talk in their language -- terms they can understand

Divide the class up into groups of 2 or 3. Have each of these small groups describe what they see and hear when those communicating with them are:

* respectful
* courteous
* empathetic
* interested in them

Allow groups to work about 5 minutes, then ask each group to report on the actions they described. At the conclusion of their listing, emphasize to the them that in order for others to communicate with them in the manner they wish, they must treat others that same way. "What goes around, comes around!" The Golden Rule, etc.

Also point out that supervisors and managers have been determined to have earned respect for the positions they hold; and should always be addressed in a positive, respectful manner.

Explain that good communication is critical to everyone's work because about 90% of the failures on the job are due to breakdowns in communication, and only 10% due to a lack of technical skills (knowing how to do the job).

Show the Calvin and Hobbes cartoon (pass it around, or make a transparency if you have use of an overhead projector). Comment that even Calvin is aware that how we say something is often as important as what we say.

Briefly explain that communication involves both talking and listening. Each of these sets of skills is essential for meaningful communication to take place. Probably one of the most difficult things for most people to do is listen.

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LISTENING

Distribute paper for participants to take the "listening" test. Stress that you will only read each question twice and you will not answer questions, but will repeat instructions, if necessary. Read the following questions and have participants write their answers beside the appropriate number.

1. Answer this question beside the number 1 on your paper:
"In this list of names -- George, John, David, Adam, James, Grace -- which names begin with 'J'?"

2. Besides your numbers 2a and 2b write the answer to these questions:
"Suppose you were given these directions: "Go to Room 3-1-5 and look in the lower right hand drawer and bring me all the boxes of pencils that are left there."
a- Would you look in the right or left hand drawer?
b- Would you go to Room 5-3-1 or 1-3-5 or 3-1-5?

3. Now beside number 3 on your paper, answer this question:
Answer True or False to this:
"In the list of words, BEE, SEE, FREE, GLEE, FLEA, ME, the second word mentioned is FREE."

4. Answer this question beside number 4 on your paper:
"Your wife asks you to bring home meat, milk, cheese, bread. You bring home milk, peas, bread and meat. What did you forget?"

5. Now beside the number 5, write your answer to this question.
"You are the driver of a school bus. At the first stop, 13 children get on. At the next stop, 8 children get on and 2 get off. At the next stop, 8 children get on. At the last stop, four more get on and one sneaks off. How old is the bus driver?

After you have read each question twice, give the participants sufficient time to complete their answers. Then go back through the questions and answers to see how well they did.

The answers and scores are as follows:

1. 20 points if they wrote down both John and James
2a 10 points for right drawer
2b 10 points for 315
3. 20 points for False -- the second word is SEE
4. 20 points for cheese
5. 20 points if they wrote their own age down.

Scores:

100 - Excellent Listener
90 - Good Listener
80 - Fair, Can Improve
70 - Needs Help!
60 or below - WOW!

MAJOR LEARNING POINTS

Give participants a blank sheet of paper. Ask them to write down a one page summary of what they learned in this lesson. Take these sheets up (their names should be on the sheets). Use these for review at the next session.

* *

SPECIAL NOTE TO INSTRUCTORS

AT THE CONCLUSION OF SESSION XVII -- "COMMUNICATING FOR QUALITY" -- ARRANGE TO HAVE TWO OF THE PARTICIPANTS TO GIVE A DEMONSTRATION AT THE NEXT SESSION (SESSION XVIII).

THE DEMONSTRATION WILL CONSIST OF ONE PARTICIPANT TALKING TO THE OTHER ABOUT HIS (THE SPEAKER'S) JOB. HE SHOULD TAKE A FEW MINUTES (ABOUT 2 TO 3 MINUTES) TO DESCRIBE WHAT HE DOES AND WHAT MACHINERY OR SPECIAL TOOLS HE UTILIZES ON THE JOB. HE SHOULD DESCRIBE THEIR FUNCTIONS.

YOU CAN INFORM THE TWO PARTICIPANTS THAT THE PURPOSE OF THE DEMONSTRATION IS TO GIVE THE OTHER PARTICIPANTS THE OPPORTUNITY TO OBSERVE A SPEAKER AND A LISTENER, IN ORDER TO MAKE CERTAIN OBSERVATIONS. THERE IS NO NEED FOR THE TWO TO REHEARSE, OR ANYTHING LIKE THAT.

* *

CALVIN AND HOBBES

LISTENING TEST

1. _____

2. A. _____

B. _____

3. _____

4. _____

5. _____

LISTENING TEST

1. John and James

2. A. right drawer

   B. 315

3. False - see

4. cheese

5. person's own age

SESSION XVIII COMMUNICATING FOR QUALITY (2)

SESSION OBJECTIVES:

At the conclusion of this session, participants will:

* have a better understanding of listening skills,
* have a better understanding of giving and receiving feed back.

TIME	CONTENT	PROCESS/ ACTIVITY	MATERIALS
10 Min.	Review	Individual Activity	Summaries From Last Session
5 Min.	Overview	Lecture	Session Objectives
10 Min.	Listening	Lecture	Handout #1
25 Min.	Getting and Giving Feed back	Guided Discussion and Individual Activity	Handout #2 & #3
10 Min.	Major Learning Points	Individual Activity and Summarizing	Blank Paper

SESSION XVIII COMMUNICATING FOR QUALITY (2)

REVIEW

Pass out the summary sheets from the last session. Use these to review the previous session.

OVERVIEW

Session objectives are for the participants to:

* Practice using listening skills
* Practice giving and receiving feedback

LISTENING

Pass out the handout, "Listening to Others". Go down the list briefly, asking participants to read the different strategies. As each one is read, ask participants for their reactions.

Go on to explain the following information (You may want to make a handout of this, or write it on the board/flip-chart).

* over half a person's waking hours are spent in listening.
* we speak at a rate of about 100-150 words a minute, but our thinking rate is about 500-600 words per minute.
* few people have ever been taught how to listen.
* our ability to listen is impaired by all the activity going on around us.
* too often we think a conversation is the other person talking while you think about what you're going to say next.
* listening is a skill and takes a conscience effort to do well, but is critical to good job performance.
* because of habits we have developed over a long period of time, we have difficulty listening.
* one of the worst things people tend to do is think they know what the other person is going to say and not listen to them, but tune them out and fill in what they miss with what they think the other person is going to say.

Ask for responses to the above. If you read these out, ask the participants to list for you the main points they just heard. Some summary responses would include:

- listening is a conscious effort
- habits keep us from really listening

Ask participants (why listening is an important skill they should learn and practice on the job.) They should come up with most of the following:

- Shows Respect
- miss things that are important
- know how to do things they need to do
- know what's really going on

GETTING AND GIVING FEEDBACK

Remind participants that they began the problem solving process in the previous two sessions. They have done both oral and written summaries of what their groups have done so far. The last step they were at involved communicating with others. They have practiced some listening and summarizing skills, which will enable them to provide the essential information people need without excessive details.

Go on to explain that (communication involves two people - it's a matter of constantly giving and receiving feedback with the person they are communicating. This is a very essential part of good communication. They must be able to give feedback to others and get it from the person to whom they are talking).

Ask (what is meant by feedback) when you are talking about communication. Participants should be able to tell you it is the indication(s) from the other person that they are getting your message. Remind participants of the things listeners did from the previous session.

Individual Activity

Distribute the handout, "Communications". Tell participants that when we communicate we use all the things listed under the heading "How We Talk". Instruct them to write in the percentage they feel equals how much of the communicating we do using each of the ways listed.

Allow about 1 minute for participants to write in their estimates. Then ask participants to tell you their estimates. Correct estimates (according to most sources) are:

body language	-- 55% --	this includes facial expressions and gestures, etc.
verbal	-- 7% --	the words we use
expression/tone	-- 37% --	inflections in voice
writing	-- 1% --	

Explain that we use each of our senses in receiving messages. Ask participants to now estimate how much we use each sense. Allow about 1 minute for estimates to be made under the heading "How We Listen" on the "Communications" handout. Then ask participants to share their estimates.

According to most sources the following estimates are given:

sight - 90%
sound - 5%
touch - 2%
taste - 1%
smell - 1%

Guided Discussion

Ask participants how they would summarize the information given. They should tell you:

* body language is an important part of communication
* we need to watch what people are saying to us
* how we say things may be more important than what What we say
* when we say things we must be sure we use the right words
* when we communicate we must be sure people understand, because people are not naturally good listeners, we don't use hearing as much as seeing in receiving messages.

Ask these questions for participants to identify what they need to watch and listen for as they talk with others to be sure they understand the message we are trying to get across.

* Why do we need feedback?

* What are things to listen for as we communicate?

* What is important to watch for when we talk to others?

Among the things identified should be:

- body language
- questions being asked
- person looking at you
- appropriate nods and shakes

Emphasize that it is important for us to give feedback to others as they are talking to us. Remind participants of what they discussed earlier -- how they like to be talked to. Some of the things that were identified at that time were:

* courteously
* like they know what they are doing
* positive
* shown respect
* calmly
* have things explained to them
* person to look at them
* their feelings being taken into consideration
* in their language -- terms they can understand

Optional Practice (if you have the time)

Pass out the Handout, "Feedback Practice". Use two of the participants in a demonstration. Have one participant talk to the other about his job performance. Take just a couple of minutes for the demonstration.

Have the other participants complete the Observer Check List. Randomly ask different participants their observations (from the check list) of the Feedback Practice.

RECAP MAJOR LEARNING POINTS

Distribute a blank sheet of paper to each participant. Have the participant take about 5 minutes to write a one page summary of what they have learned about the listening and communication skills.

LISTENING TO OTHERS

1. WANT TO LISTEN. Almost all problem in listening can be overcome by having the right attitudes.

2. ACT LIKE A GOOD LISTENER. Be alert, sit straight, let your face radiate interest.

3. LISTEN TO UNDERSTAND. Do not listen just for the sake of listening; listen to gain a real understanding of what is being said.

4. REACT. The only time a person likes to be interrupted is when applauded. Be generous with applause. Applaud with nods, smiles, comments, and encouragement.

5. STOP TALKING. You can't listen while you are talking. Communication is not just taking turns talking.

6. EMPATHIZE WITH THE OTHER PERSON. Try to put yourself in the other's place so that you can see that point of view.

7. ASK QUESTIONS. When you don't understand, when you need further clarification, when you want the other person to like you, when you want to show you are listening; but don't ask questions that will embarrass or "put down" the other person.

8. CONCENTRATE ON WHAT THE OTHER IS SAYING. Actively focus your attentions on the words, the ideas, and the feelings.

COMMUNICATIONS

How We Talk	How We Listen
_____Body Language	_____Sight
_____Verbal	_____Sound
_____Tone of Voice	_____Touch
_____Writing	_____Taste
	_____Smell

COMMUNICATIONS

How We Talk	How We Listen
55% Body Language	90% Sight
7% Verbal	5% Sound
38% Tone of Voice	2% Touch
1% Writing	1% Taste
	1% Smell

FEEDBACK PRACTICE

OBSERVER CHECK LIST

Did the Listener:

face the speaker	Yes	No
have good eye contact	Yes	No
nod or shake head appropriately	Yes	No
appear comfortable	Yes	No
ask questions for understanding	Yes	No
refrain form interrupting	Yes	No
tend to lean toward the speaker	Yes	No

Other things the listener did to encourage the speaker and/or show interest:

Overall rating of the listener _____.

Did the Speaker:

express himself/herself clearly	Yes	No
look at the listener	Yes	No
have good eye contact	Yes	No
use terms the listener could understand	Yes	No
answer questions well	Yes	No
seem interested in the listener	Yes	No

Other things the speaker did to encourage the listener and/or show interest:

Overall rating of the speaker_____.

POST-TEST

NAME: _____

DATE: _____

TRUE or FALSE

Place a + in the blank for true and place a 0 for false.

_____ 1. SPC is a concept of "prevention" versus a concept of "detection".

_____ 2. Visual inspections are okay, but have no real role in quality control.

_____ 3. Because machines make parts, there are no difference between any two parts. They are all exactly alike.

_____ 4. Control charts can only measure characteristics which can be measured with precision instruments.

_____ 5. The probability theory says that we will never able to tell what might happen next in a process.

_____ 6. Variations are caused by both common and intentional causes.

_____ 7. Improved quality will help to increase production and reduce costs of production.

_____ 8. SPC improves quality by allowing a worker to see what is happening and take quick action to prevent defects.

_____ 9. In order to find out what a printed sheet is about you would have to read the whole page.

_____10. Quality is the responsiblity of Quality Control employees only.

_____11. A blueprint is to show the views and drawings of an object and how they fit together.

_____12. If we don't have hearing problems, we don't have any hearing problems.

_____13. We use our hands, arms, face, eyes, and other parts of our body to talk with more than we use our mouths.

_____14. There is no set way to problem solve because a person's first response is always the best.

_____15. Decimals and fractions are just different ways of writing the same number.

_____16. The range on a control chart specifies how much discrepancy is allowed in the measurement of the part.

_____17. Most decisions are made or problems solved should be based on collected data.

_____18. Inaccurate data is worse than no data at all.

MULTIPLE CHOICE - Write the letter of the best answer in the blank.

_____ 1. The three main purposes of collecting data are to :
a. analyze, control and inspect a product or process.
b. locate, examine and fire problem people.
c. plot points, look at charts and file away control charts.

_____ 2. Control Limit lines are:
a. used to decide when to make adjustments to process or leave it alone.
b. a statistical signal that something is abnormal and needs investigation.
c. both of the above.
d. none of the above.

_____ 3. The qualtiy of a product is defined by:
a. the machien operator.
b. quality department.
c. supervisors.
d. customer.

_____ 4. Quality is important to industry because of:
a. customer satisfaction.
b. world wide competition.
c. will help increase productivity.
d. all of the above.
e. none of the above.

_____ 5. 23" +/- 3/16" means that this wire can be cut in the range of:
a. 22 3/4" to 23 1/4"
b. 22 13/16" to 23 3/16"
c. No longer than 22 3/16"

_____ 6. SPC stands for:
a. Standard Production Capabilities.
b. Statistical Process Control.
c. Strategic Production Control.

_____ 7. Sections of the blueprint which shows drawings and dimensions describing the parts of the assembly.
a. bill of materials
b. body
c. title block

_____ 8. Most tools used in industries are based on the:
a. metric system.
b. English system.
c. American system.
d. none of the above.

_____ 9. One of the first leaders of quality control who has helped to develop many of its ideas and practices is:
a. George Bush.
b. Edwards Deming.
c. Lee Iacoca.
d. Henry Ford

_____10, Random sampling is most desirable because it is:
a. cheaper.
b. less time consuming.
c. more accurate and less destructive.
d. all of the above.
e. none of the above.

ADD:

1. 1 / 4 / 8 / 16

2. 1 3/4 / 5/8 / 1/2

3. .865 / .25

4. 25.16 / .005

SUBTRACT:

1. 2 3/4 / 2/5

2. 3/4 / 3/8

3. 1.3745 / 1.3720

MULTIPLY:

1. 1 1/2 / 3/4

2. 21.3 / 1.2

3. 1.6 / 1.2

DIVIDE:

1. 1/2 ÷ 1/4 =

2. 24.5 ÷ 1.4 =

3. 2.63 ÷ .8 =

Answer the following:

1. Specifications given on a print are 67.5 +/- .050.
   a. What is the largest the measurement could be?

   b. What is the smallest the measurement could be?

Round off the following numbers to the nearest tenth.

1. 1.279 = 2. 45.361 =

3. .981 = 4. 12.645 =

5. .609 =

Answer the following questions using the chart below:

1. How far is it from New Orleans to New York? ___

2. How far is it from Chicago to Los Angeles? ___

AUTOMOBILE MILEAGE	Chicago, Ill.	Denver, Colo.	Houston, Tex.	Los Angeles, Calif.	Miami, Fla.	New York, N.Y.	San Francisco, Calif.
Atlanta, Ga.	671	1436	852	2245	663	868	2579
Boston, Mass.	992	2016	1865	3004	1615	220	3265
Chicago, Ill.		1062	1139	2115	1352	824	2240
Cleveland, Ohio	311	1393	1372	2393	1327	493	2571
Dallas, Tex.	923	820	241	1476	1367	1580	1790
Denver, Colo.	1062		1061	1148	2104	1794	1324
Detroit, Mich.	271	1333	1306	2415	1437	670	2511
Houston, Tex.	1139	1061		1585	1256	1714	1950
Las Vegas, Nev.	1905	843	1426	305	2572	2637	624
Los Angeles, Calif.	2115	1148	1585		2841	2784	411
Memphis, Tenn.	579	1054	560	1816	1050	1114	2214
Miami, Fla.	1352	2104	1256	2841		1395	3192
Montreal, Quebec	804	1866	1839	2948	1749	381	3044
New Orleans, La.	981	1326	360	1945	896	1360	2206
New York, N.Y.	824	1794	1714	2784	1395		3043
Philadelphia, Pa.	766	1770	1624	2726	1278	90	3021
Portland, Oreg.	2255	1329	2295	1098	3433	2992	687
St. Louis, Mo.	283	848	856	1832	1346	1057	2168
Seattle, Wash.	2076	1411	2377	1280	3421	2852	869
Toronto, Ontario	469	1531	1504	2613	1631	513	2709
Washington, D.C.	701	1696	1476	2680	1130	238	2968

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CHOCTAW WORKPLACE LITERACY PROGRAM

MISSISSIPPI SKILLS ENHANCEMENT PROGRAM

Company Name_____ Community College District_____

EXIT FORM

Identification number: _____ Date: _____

1. Did you find the training in this program useful?

   Yes_____ Somewhat_____ No_____

2. Did the information presented in class help you know more about your job?

   Yes_____ Somewhat_____ No_____

3. Are you able to use the knowledge you gained from this program away from your job?

   Yes_____ Somewhat_____ No_____

4. Was this program what you expected it to be?

   Yes_____ Somewhat_____ No_____

5. Was the material covered in the program too difficult?

   Yes_____ Somewhat_____ No_____

6. Was the instructor well-prepared?

   Yes_____ Somewhat_____ No_____

7. Did the instructor present the material well?

   Yes_____ Somewhat_____ No_____

8. Was the length of each program session (in hours)

   Too long_____ Too short_____ About right _____

9. Was the length of the program (in weeks)

   Too long_____ Too short_____ About right _____

10. Would you like to participate in other programs like this?

    Yes_____ Maybe_____ No_____

11. How are you using the information that you got in this program?

    On the job: _____

    Off the job: _____

12. What would you do to improve this program? _____

    _____